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Topics of the Month

Action on the Cremer report

AFTER nearly a year's consideration of the Cremer report on chemical engineering research, the chemical industry and the plant manufacturers have turned down for the present its main recommendation : the establishment of a central chemical engineering research organisation. This decision is disclosed in the annual report of the Association of British Chemical Manufacturers published last month. It is stated that after discussions with the British Chemical Plant Manufacturers Association, it has been jointly agreed that the proposal to form a research association is premature.

The reason given is that there is already a great deal of research being done by chemical firms, oil companies, research associations and universities and that it is necessary to discover precisely the gaps in existing knowledge before discussing the need for a central research organisation. This will surprise those who think that the Cremer report, drawn up by a number of experts in close touch with all the chemical engineering research interests, has already indicated these gaps. There is one section in the report describing 'outstanding requirements for research for which adequate facilities are not available' and an appendix ('A') listing items for immediate investigation. It would seem that to tackle only some of these problems would provide enough work for the projected research body.

However, this is not the view of the A.B.C.M. and the B.C.P.M.A. Accordingly they have appointed Major F. H. Bramwell, who has just retired as chief engineer of I.C.I. General Chemicals Division 'to investigate the chemical engineering needs of the chemical and chemical plant industries based on the suggestions made by the various organisations enumerated in Appendix 'A' of the Cremer report.' His job is to find out what unpublished data are already in their possession and the nature of any chemical engineering research they have in hand and whether and under what conditions they are prepared to make any such basic data generally available. The idea is that then Major Bramwell will report jointly to the two associations outlining chemical engineering needs in relation to the information available and the research in hand, with recommendations for further action.

Research costs money and it is understandable that the people who will have to provide it wish to be quite sure that it will not be spent on work which has already been done or is in hand. To this extent the action of the two associations is justified. However, it is to be hoped that the investigation now to be carried out by an independent expert will not itself duplicate the work of the Cremer committee.

Petroleum chemicals at Wilton

THE new olefine plant of Imperial Chemical Industries at Wilton Works, Yorkshire, is a most important addition to the British petroleum chemicals industry. As mentioned in our description on another page, the plant has a capacity for making over 30,000 tons p.a. of ethylene and a similar quantity of propylene, besides upwards of 30 million gal. of petrol. It uses annually about 250,000 tons of a light oil fraction specially selected for giving a high yield of ethylene. Precise output figures are not available, because the whole project has purposely been designed to provide flexibility in the range of products made. Thus, for example, should there be a decline in the demand for ethylene, the production of petrol could be raised. However, the plant is essentially a petroleum chemicals producer, not a petrol refinery. Present indications are that, far from the demand for ethylene and propylene declining, there is every prospect of more being required. Billingham Division of I.C.I., the operators of the plant, have decisively broadened their activities from the original base of inorganic chemistry (ammonia, nitric acid, sulphate of ammonia, etc.) and are now heavily committed in the heavy aliphatics field. Ethylene is now being used to make ethylene oxide for detergents and ethylene glycol for anti-freeze. In the polymer field it is used to make polythene and, through ethylene glycol, the polyester fibre known as *Terylene*. The *Terylene* plant is the biggest of the new Wilton projects. It will cost £10 million and turn out 11 million lb. p.a. of the remarkable new fibre. Already a so-called pilot plant is making no less than 600,000 lb. p.a. and this may be doubled by next year. The new factory will not be ready until 1954.

The propylene stream from the olefine plant now goes to Billingham for conversion into isopropanol and then into acetone, which latter is used to make *Perspex*. By-product hydrogen generated in the acetone conversion process augments Billingham's synthesis gas supply. In the C_4 stream from the olefine plant, now blended with petrol or used for fuel, there are significant quantities of butadiene, the utilisation of which is being actively considered.

The olefine plant is thus the heart of the new organic chemical industry which is being developed on Tees-side. As we saw on our visit to Wilton, the present units, large as they are, represent not the end but the beginning of the projects scheduled for this site. Apart from its size, the plant is unique in that its chemical products are all intended for use within the I.C.I. complex, in contrast to, say, the Shell plant at Stanlow designed to produce solvents for direct sale, and the Petrochemicals Ltd. plant at Manchester designed to make a wider range of chemicals for a similar purpose.

Nitrogen removal from natural gas

THE rapid rate at which natural gas reserves are being used to satisfy the ever-increasing demand forecasts the necessity for using supplies of increasingly higher nitrogen content. Proposals have been made to remove part or all of the nitrogen prior to transmission, as a means of lowering pumping costs by increasing the effective pipeline thermal carrying capacity. Of added interest is the storage of natural gas as liquid, which requires the separation of nitrogen in the liquefaction process to increase the effective capacity of storage systems and to avoid fractionation and consequent change of composition and heating value upon gasification.

A thorough search of the literature by the Institute of Gas Technology, Chicago, revealed that the published data on the physical and physico-chemical properties of methane, nitrogen and methane-nitrogen mixtures were extremely limited in range and quantity, and of doubtful accuracy.

Since the available data were considered entirely inadequate for engineering design purposes, the Institute set about developing the necessary equipment and procedures for determining the important physical and thermodynamic properties of methane, nitrogen and methane-nitrogen mixtures, to obtain the necessary data, and to present this information in useful form for engineering calculations.

An apparatus was designed and constructed at the Institute for the determination of the conditions of pressure and temperature under which mixtures of methane and nitrogen can be liquefied. With use of this equipment, precise vapour-liquid equilibrium data have been obtained. The reliability of the equipment and procedure used was established by comparing the vapour pressure and saturated vapour and liquid density data obtained experimentally, for pure methane and pure nitrogen, with the best available published data. The checks obtained were excellent and, with this assurance, the study of the methane-nitrogen system was begun.

The data obtained, which is needed for engineering design of nitrogen-removal equipment, is now presented for the first time in 'Physical-Chemical Properties of Methane-Nitrogen Mixtures,' Institute of Gas Technology Research Bulletin No. 17, by O. T. Bloomer and J. D. Parent.

Chemical opportunities in Canada

DRAMATIC advances are going on in the field of chemical production in Canada. The country is exceptionally well placed to go ahead in this field, with plenty of electric power and a large indigenous supply of materials. New investment in chemicals has been consistently higher than the average investment in industry ever since the beginning of the war. Employment almost doubled between 1939 and 1950. Some 200 new establishments were opened up, most of them by existing companies. Since the war about 44 new medium-sized and large firms have started production. The industry expects to go ahead faster than ever in 1952 with planned developments estimated to cost $100 million, an increase of more than 80% over the actual new investment in 1951 of $53.2 million.

At present the main concentration of the Canadian industry is at Sarnia, in the province of Ontario, where projects totalling $30 million in value are being developed. But expansion is also taking place in the provinces of Alberta and Quebec. In Alberta the emphasis is on petro-chemicals. Work on a petro-chemical plant in the Edmonton area is already under way. It is expected to go into operation in early 1953, and to cost $54 million in all. Also in the Edmonton area work has just begun on a $13 million plant for the production of polythene, which is due to go into operation at the end of 1953. It is probable that the natural gas resources of Alberta will prove a magnet to other branches of the chemical industry, which also find *in situ* many of the raw materials they need, such as salt and limestone.

In the province of Quebec important developments are under way in Montreal East and in the town of Varennes on the south shore of the St. Lawrence, where a public utilities company have acquired an extensive riverside site on which an integrated chemical industry is expected to

develop. Already three projects are planned there, at an eventual cost of some $20 million. Three other projects, costing about $12 million, are under way in East Montreal, while at Shawinigan Falls a new plant is planned for the production of vinyl chloride dispersion resins.

In all these fields of development British business is supplying some of the equipment required. In general, Canadians are disposed to welcome greater British participation—provided they can be assured of regular deliveries on time, and of reliable facilities for servicing and spares. The market is highly competitive, but if the British producer's offer compares well on commercial grounds with those of his competitors he can be sure of meeting goodwill in Canada. Manufacturers will also realise the need for maintaining first-class representation on the spot. Projects of the type outlined above require to be nursed patiently long before the calls for tender are issued by the promoters. There is plenty of experience to show that a determined effort to win and keep a place in the Canadian market is likely to win its due reward in the long run.

Rayon in wartime Germany

ABELATED, but none the less critical, comprehensive and valuable technical appraisal of the achievements of the German rayon industry during the war appeared last month.* It presents a general view of the industry as revealed in the numerous Allied intelligence reports, prepared by teams that made investigations after the war. Dr. A. R. Urquhart, research superintendent of Lansil Ltd., was responsible for its preparation and, quite rightly, he has gone beyond mere condensation of facts and made criticisms and assessments of tendencies as he saw fit. The report considers the industry not only in Germany but also in German-dominated countries like France, Holland and Italy. Furthermore, the word ' rayon ' is used as ' a generic term applied to all fibres for textile use which are not of natural occurrence,' a definition originally suggested by the Textile Institute, but not now recognised by them and probably no longer generally acceptable.

Much of the ingenuity and skill of German textile chemists and technologists had to be used to make possible the utilisation of substitute raw materials, owing to difficulties in importing, for example, spruce pulp and cotton linters. In general, therefore, in the pulping industry ' much energy and ingenuity was devoted to the solution of problems that in a saner world need never have arisen.' In the opinion of the author, the concentration of effort on these ends inevitably resulted in an almost total lack of significant accomplishment in the field of general cellulose chemistry and technology.

There is much more real progress to record on the more purely chemical side of what is fundamentally a branch of chemical industry. At the chemical end, the activities of German rayon factories were even more varied that those we are accustomed to in Britain. At the I.G. Farben factory at Wolfen, for example, it was possible to see trees entering the factory and viscose yarn made from them leaving it, as well as a host of other chemical and fabricating processes. Again, at the Lonza factory, primarily devoted to the production of cellulose acetate flake for their associated rayon factory a few miles away, production started with the manufacture of calcium carbide from coke and lime and continued with the manufacture of acetylene, the hydration of acetylene to acetaldehyde, the oxidation of acetaldehyde to acetic acid, and the conversion of acetic acid to acetone and acetic anhydride. In the manufacture of the last-named chemical the Wacker concern was supreme; all German factories used their ketene process. Two other processes were seen. In one, acetaldehyde is oxidised to acetic acid using, instead of manganese acetate, a mixture of copper and cobalt acetates and thus producing both acid and appreciable quantities of acetic anhydride. This process was of great interest to cellulose acetate makers, who used the acid/anhydride mixture for acetylating. In the other method of preparing anhydride, olefines, carbon monoxide and water were reacted at about 230°C. in the presence of nickel carbonyl.

J. W. Reppe and his acetylene chemistry crop up in the report. Of the many important advances made by the Reppe group, the most significant for the rayon industry was the discovery of the reaction between acetylene and aqueous formaldehyde which yields 1:4 butinediol which can be hydrogenated to 1:4 butanediol, an important raw material of polyurethane manufacture, which in turn can be readily dehydrated to tetrahydrofuran. This is both a useful solvent for rayon manufacture and an ingredient, with CO and water, of adipic acid, the most useful dibasic acid for making polyamide rayons.

**The German Rayon Industry during* 1939-1945. H.M.S.O. Pp. 360. Illus. 25s. net.

Chemistry and the new metals

THE enormous breadth of the advancing front of chemistry was well illustrated by Prof. W. Wardlaw in his presidential address to the Chemistry Section at the British Association meeting in Belfast recently. His remarks embraced topics as diverse as zirconium and luncheon sausage, atomic energy and silicones. In painting this great canvas his strokes naturally had to be broad and swift. However, he did find time to dilate on some recent chemical achievements with the rarer elements, particularly the less common metals. Zirconium, he pointed out, was entering a new era. It was outstandingly corrosion resistant and its very small affinity for neutrons commended its use in building atomic power plants. The carbide of zirconium was in the news as a source of zirconium tetrachloride for the production of the metal. Zirconium appeared to have an important future in alloys made by arc melting in argon or helium atmospheres.

Another metal difficult to prepare but now turned out in hundreds of pounds by advanced chemical methods was titanium. Although the more optimistic predictions for titanium as a high-temperature material were not fulfilled, it continued to be a metal of quite exceptional promise in aircraft, marine and armament work. Now electrolytic methods for its production were being explored in attempts to produce it in greater quantities. Another recent achievement in the field of the lesser known metals was the production in the U.S. of pure hafnium metal. Hafnium is always found as an impurity in zircon sand used to make zirconium.

Another rare metallic element which was now being commercially produced was germanium, used to make crystal triodes for radio sets. Germanium is present in unusually high amounts in certain British coal. The commercial process for its manufacture involved its extraction from flue dust. Sir Gilbert Morgan, a former director of the Chemical Research Laboratory, had established that its greatest con-

centration was in the dust deposited in the flues of gas-works producer plants.

Finally, in this part of his address, Prof. Wardlaw discussed what he called a revolution in iron and steel making, the construction at Liege of a new type of blast furnace which will run on pure oxygen. Nine countries, including Britain, had co-operated in this venture. Chemists had helped to develop the idea and its successful exploitation depended on the chemical industry's ability to make great tonnages of cheap oxygen.

The van't Hoff centenary

TWO propositions thrust themselves at anyone reading the history of chemistry. The first is that many fundamental discoveries achieve recognition only with great difficulty. The second is that it is frequently the scientist's fate to have his theory remembered while he, as a person, is forgotten. Jacobus Heinricus van't Hoff, who was born 100 years ago on August 30, 1852, illustrates both propositions. Van't Hoff's interest in chemistry began when he was at school in his home town of Rotterdam; he and some friends used secretly to go back to school in the evenings to do chemical experiments. When this was discovered and forbidden, he transferred the experiments to his home and hit on the idea of charging spectators so as to finance further work.

When he left school he studied at Delft Technical Institute, with a view to becoming an industrial chemist, but he abandoned this idea after a vacation job in a sugar factory and spent the next year taking a degree at the University of Leiden. He then went to work under Kekule at Bonn, a town that enthralled him. 'At Leiden, all was prose,' he wrote. 'At Bonn, all is poetry.' He added more than a little to this poetry himself, including a long, if impersonal, elegy (in English) to a 'lady student' who had committed suicide.

Next he went to Paris, to work under Wurtz. There he must have met Wurtz's assistant, Le Bel, who, by a remarkable coincidence, was later to put forward exactly the same theory as van't Hoff about organic structures. Van't Hoff returned to Holland to work for his doctorate at Utrecht.

The organic chemical thesis for which he was awarded this in 1874 is justifiably forgotten, but a ten-page pamphlet, published a few weeks earlier, guaranteed his place in history. It was in this paper, published when he had just turned twenty-two, that he put forward the idea of the asymmetric carbon atom as the explanation of the physical differences between isomers that had already been the subject of Pasteur's work. Nobody paid much attention to the original pamphlet so in May 1875 van't Hoff reprinted it in French under the title: 'La Chimie dans l'Espace.' Soon after he published a German version.

The reception was generally unfavourable. 'A Dr. van't Hoff of the Veterinary Institute of Utrecht' (the only position he had been able to obtain) 'appears to have no taste for exact chemical research,' wrote Kolbe. 'He finds it a less arduous task to mount his Pegasus' (evidently borrowed from the Veterinary Institute) 'to soar to his chemical Parnassus, there to reveal in his "La Chimie dans l'Espace" how he finds the atoms situated in the world's void.' Wislicenus, who supported van't Hoff, got much the same treatment. He was said to have 'gone over from the camp of the true investigators to that of the speculative philosophers of ominous memory, who are separated by only a thin medium from spiritualism.' Nonetheless, the support of Wislicenus was critical and the theory which, as mentioned above, was announced independently and more or less simultaneously by Le Bel, was accepted.

A few years later (he was still only twenty-six) van't Hoff was appointed Professor at Amsterdam, and it was here that he did his work on reaction velocities, culminating in the publication of 'Etudes de Dynamique Chimique,' and even more pioneering work on osmotic pressure which led to the astonishing result of being able to apply the gas laws to the osmotic pressures of solutions.

His last appointment was in 1885, to a professorship in Berlin where he spent the rest of his life studying the problems of solution and the conditions of formation and separation of the salts of the Stassfurt deposits. He died on March 11, 1911. Incidentally, his successor to the chair at Berlin was Albert Einstein. By this date, van't Hoff was probably Europe's most distinguished physical chemist. When the Nobel prizes were instituted he was the first person to be awarded one for chemistry. Yet even now the Encyclopaedia Britannica has no personal reference to him. He is mentioned only in the various sections on physical chemistry.

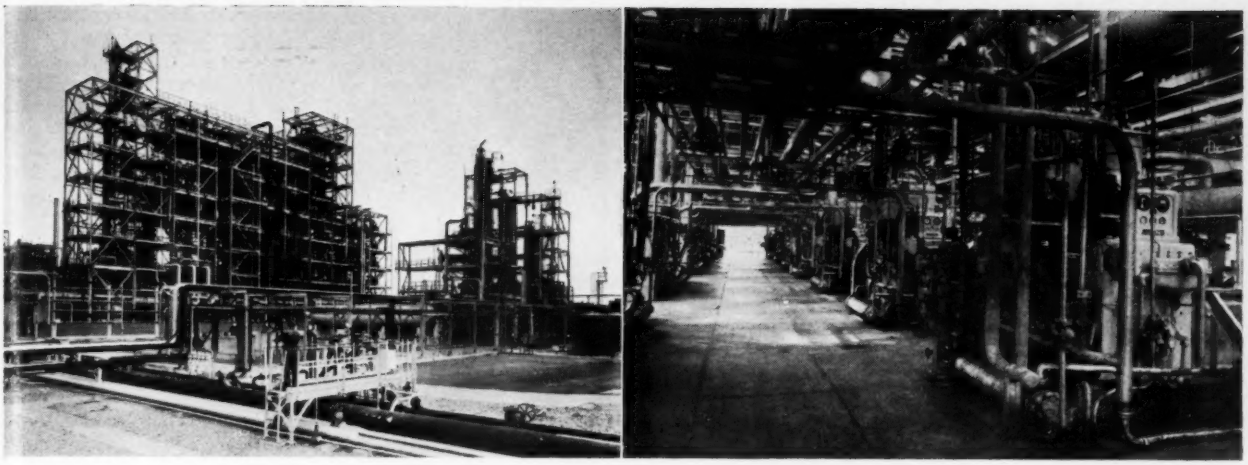
Nuclear engineering at London University

NUCLEAR engineering has been added to the final year of the three-year B.Sc. engineering course at Queen Mary College, London University, and may be taken by electrical and mechanical engineering students as one of four subjects. Mr. W. K. Mansfield, lecturer at the college, tells us that the new course will cover an introduction to nuclear physics, the theory and design of nuclear reactors, the applications of radio-isotopes, measurements and health physics. Experimental work will include vacuum technique and measurements of intensity, absorption and half-lives with ionisation chambers, Geiger counters, neutron detectors and scintillation counters.

In order that the subject should be a 'live' one, research work will be undertaken by post-graduate students supervised by the lecturing staff. The programme will be directed along two main lines, the design of accelerator machines and the application of radio-isotopes. The department possesses a 1-MeV Van de Graaff generator and a small 4-MeV Betatron. One project of interest to chemical engineers will be the construction of an impulse electron accelerator, or Capacitron as it is known in America. This has been used for the sterilisation of food and drugs and also as a polymeriser. These machines will be housed in the nuclear particle laboratory which has just been completed.

The Electrical Engineering Department of Queen Mary College has carried out research in high-voltage engineering for the past 20 years. Since the war, a natural extension of this work has been the study of high-voltage accelerators and their application to (1) fundamental research in nuclear physics, (2) the production of radio-isotopes and (3) radiotherapy.

The more economical production of radio-isotopes by nuclear reactors has resulted in the availability to research workers of a powerful new tool. Of more importance ultimately, no doubt, will be the production of power from such reactors. It was consequently thought that these developments would create a demand by industry and the Government for a small number of engineers who had been introduced to the fundamentals of these subjects during their undergraduate training, and the new course is being introduced this year on an experimental basis.



PETROLEUM CHEMICALS BY I.C.I.

New Plant at Wilton makes Ethylene, Propylene and Petrol

A petroleum chemicals plant with a capacity for processing 250,000 tons of feedstock p.a., is now being operated by the Billingham Division of Imperial Chemical Industries Ltd. at Wilton, Yorkshire. The major chemical products are ethylene and propylene, which are the starting materials for a large number of important products, including polythene, detergents, anti-freeze, 'Perspex' and, eventually, the new polyester fibre 'Terylene.' Considerable quantities of petrol are also produced. This olefine plant, one of the largest undertakings carried out by I.C.I., is described in the following article based upon a recent visit to Wilton.

WILTON works is the biggest chemical project in Britain, perhaps in the world. On a site of some four square miles, I.C.I. are providing accommodation and services for plants to be operated by the company's various Divisions. The first stage of development, which has cost more than £22 million, is completed by the construction and operation of the petroleum chemicals plant, or olefine plant as it is called by the company. This plant and the actual development of the Wilton site to its present state has absorbed much of the capital expenditure to date. Other plants now in operation at Wilton include units for making ethylene oxide, ethylene glycol, polythene, *Lissapol N* detergent, formaldehyde, *Perspex* sheet and phenol formaldehyde moulding powder.

Work will shortly start on a *para*-xylene plant which, with the ethylene glycol plant, will provide the two main organic raw materials needed for *Terylene*. The plant to make this polyester fibre at the rate of 11 million lb. year will, it is hoped, be in operation at Wilton by 1954. Space is also reserved at Wilton for a second olefine plant should it be needed. The ethylene oxide and glycol plants have also been laid out to make their duplication easier, if necessary. Two new polythene plants are under construction, as is a plant for the manufacture of caustic soda and chlorine by electrolysis of brine. When this is completed, next year, the ethylene oxide plant will take chlorine direct from it, instead of using liquid chlorine brought by rail tankers, as at present. Finally, schemes are being considered for utilising the considerable quantities of butadiene now available from the olefine plant.

I.C.I.'s need for ethylene developed with their interest from the 1930s onward in ethylene glycol and later polythene and non-ionic detergents based on ethylene oxide. *Terylene* represents another big demand for ethylene. From propylene is obtained acetone, used in the manufacture of methyl methacrylate or *Perspex*. Other solvents, including isopropanol, are also obtainable from propylene.

These were the reasons behind I.C.I.'s decision to enter, through the Billingham Division, the petroleum chemicals industry. Owing to the complete novelty of this venture I.C.I. took the step, unusual for them, of asking contractors to tender for the main plant to produce ethylene and propylene. Ethylene of great purity is required for polythene manufacture and, with this in mind, the company were attracted to a new process of oil pyrolysis developed by M. W. Kellogg Co., of New York. Even though this process had been operated only on a laboratory scale, I.C.I. technicians were so convinced of its suitability that they asked Kellogg to go right ahead with the full-scale plant. Support for this bold step was forthcoming when I.C.I. conducted their own experiments and reproduced the results obtained by Kellogg.

(*Above*) **The Olefine plant. Gas separation and petrol refining units** (*left*) **and refrigeration compressors.**

The petroleum chemicals complex consists of three plants: the olefine plant comprising pyrolysis, gas separation and petrol treatment sections; the ethylene oxide plant; and the ethylene glycol plant. Most of these units are in the open. All are highly instrumented and great attention has been given to the design and layout of the control rooms where graphic panels are employed. Ample space has been allowed between plants, except where two are operated from a common control room and form, in effect, a single plant.

Strict fire precautions are observed in the whole area. There is, of course, a complete ban on smoking and everyone must surrender matches or lighters before entering the area. The gas separation section is considered the most hazardous and it is surrounded by a brick wall and a system which can generate a 30-ft. wall of steam to drive down vapours from any accidental spillages.

The olefine plant

The plant has been designed to run under a variety of operating conditions so as to give as much flexibility as possible. The feedstock rate may vary from 50 to 75 million gal./year of light distillate oil and the petrol made from one-third to two-thirds of this amount. The designed output is over 30,000 tons/year of ethylene and a similar quantity of propylene.

A tour of the plant starts with the two 2.75-million-gal. feedstock storage tanks with floating roofs. These are duplicated at Teesport where the feedstock is received from tankers. Nearby are four smaller refined petrol storage tanks. There are seven pressure storage vessels for propylene and butylene, an extensive water cooling system and a flare stack.

The cracking process

The principle of the process is that most of the heat of pyrolysis is supplied by mixing hot oil vapour with steam at a still higher temperature. Most of the pyrolysis then occurs in a soaker line which connects the mixing point of the oil vapour and steam to the quench devices. Thus, even though high pyrolysis temperatures are obtained, there is no risk of coke forming inside the tubes carrying oil vapour.

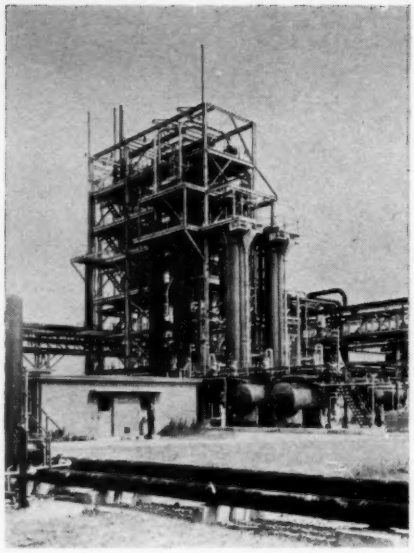
The low partial pressure of the oil vapour in the soaker makes it possible to obtain a high ratio of olefines to saturated hydrocarbons having the same number of carbon atoms. The reactions take place very rapidly at the high temperature, and the time of residence in the soaker line is of the order of one second.

The olefine plant, the heart of the petroleum chemicals scheme, can be considered in its three sections: pyrolysis; gas separation and petrol treatment.

The pyrolysis section has two tubular oil heaters and two tubular steam heaters. Each oil and steam heater feeds one soaker line where the oil is cracked at high temperature. From the soakers the products pass into waste heat boilers which rapidly quench them to a temperature at which no further reaction occurs, while at the same time generating 250 p.s.i.g. steam. The products then enter the primary fractionator, where the small amount of heavy oil formed in the reaction is separated and used subsequently as fuel. Water produced by condensation of steam is also separated and there remains the gas formed by the pyrolysis reaction and a crude petrol.

Gas separation

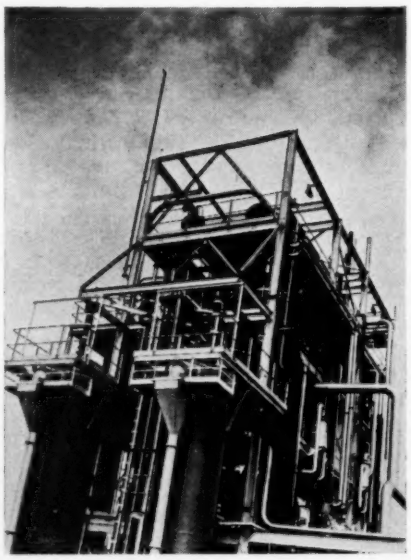
Neither of these products is completely free from traces of the other, so both go to the gas separation section, which comprises groups of compressors for process gas and for refrigeration; means of removing hydrogen sulphide, acetylene and water vapour from the process gas; and, finally, a train of stills, operating under pressure and at sub-atmospheric temperatures, which carry out the actual separation of the complex gas mixtures. Kellogg



Ethylene oxide plant.

proposed a somewhat lower pressure for these separations than is normally employed. This necessitated rather lower temperatures, but had the advantage that the separation of ethylene and ethane became easier than if the pressure were higher. All the compressors, both for process gas and for refrigeration, are driven by gas or oil engines. Such drives avoid the heavy capital outlay needed today for steam generation and the complexities associated with variable-speed electric drives.

Refrigeration is provided by an ammonia absorption system wholly operated, except during the start-up, by low-grade waste heat, then a three-level ethylene refrigeration system in cascade with ammonia and, finally, to reach the lowest temperatures, a small methane refrigeration system cascaded with the ethylene system. The product streams from the gas separation section are tail gas (a mixture of hydrogen and methane), high-grade ethylene, an ethane stream, a propylene-propane stream, a stream containing mainly butylenes and butadiene, and crude debutanised petrol. Because of the high temperatures achievable in pyrolysis and the low partial pressure of oil vapour, there is not only a relatively high yield of ethylene and a relatively high concentration of ethylene in the gas, but also high ratios of ethylene to ethane, of propylene to propane, and of butadiene to other 4-carbon hydrocarbons. In addition, by varying the ratio of steam to oil, a considerable degree of flexibility in product distribution is possible. Within limits, the plant can be run to match demands for ethylene and propylene when the consuming plants desire to vary their offtake independently.



Close-up of the reactors of the ethylene oxide plant.

The crude debutanised petrol from the gas separation section is transferred to the petrol treatment plant, where it is treated in the vapour phase with phosphoric acid to remove any gum-forming impurities. This process is operated under licence from members of the Shell group of companies.

The utilisation of the product streams from the olefine plant is undertaken by the various Divisions in the I.C.I. company.

Part of the tail gas is used as fuel on the olefine plant, but the larger portion is transferred to Billingham where, in admixture with steam, it is catalytically converted into synthesis gas ($H_2 + CO$) for use in the production of ammonia.

Ethylene oxide

Ethylene is used at Wilton and sent also to other I.C.I. factories. At Wilton it is used in part by the Billingham Division to make ethylene oxide by the chlorhydrin process, in which ethylene and chlorine in a ratio of 2: 1 by volume react together with water to form ethylene chlorhydrin. This is saponified by milk-of-lime in the presence of live steam to generate ethylene oxide, which is driven off as a vapour, together with the by-products ethylene dichloride and dichloro diethylether, which are formed in simultaneous side reactions. The ethylene oxide is purified and concentrated by distillation at atmospheric pressure for subsequent use in the manufacture of ethylene glycol and *Lissapol N.*

Ethylene glycol

This is made by the Billingham Division at Wilton by the direct hydration of ethylene oxide at 200°C. and 20 atm. pressure. By evaporation and distillation, ethylene glycol is separated from the resultant dilute glycols, while diglycol, the greater part of the by-product polyglycols, is also separated as a marketable product. The plant has a capacity of nearly 5,000 tons p.a. of ethylene glycol.

Another ethylene-derived product made at Wilton (by the Dyestuffs Division) is

Lissapol N liquid detergent, produced by linking ethylene oxide with alkyl phenols. But the greater part of the ethylene is polymerised at high pressure to polythene by the Alkali Division at Wilton. This Division devised, and now operates, the road tankers which convey ethylene from Wilton to the Winnington works of the Alkali Division and the Huddersfield works of the Dyestuffs Division.

Propylene utilisation

Through the 1,750-ft. tunnel under the Tees forming part of a 10-mile pipeline link the propylene stream is pumped as liquid to Billingham where part is converted to isopropanol by direct hydration at high pressure and temperature over a catalyst, while the remainder is carbonylated to butanols which are separated into *n*- and *iso*butanol. The isopropanol in the form of its azeotrope (*i.e.* the minimum boiling mixture of isopropanol with water) is partly converted into pure isopropanol and partly into acetone. Dehydrogenation of isopropanol vapour over a solid catalyst in a gas-heated tubular reactor is the process used to make acetone, which is recovered by absorption in water and then purified and concentrated by distillation. By-product hydrogen produced in the reaction is used to augment the factory synthesis gas supply.

Petrol manufacture

A mixture of butanes, butenes and butadiene comprises the C_4 stream which is at present transferred to Billingham, where it is blended with petrol or used for fuel. As mentioned, the quantity of butadiene available in this stream is considerable and its concentration is favourable to economic extraction, so that schemes for its extraction and utilisation are being developed.

The refined petrol is also transferred to Billingham, where it is blended. It passes through the pipeline link already mentioned. The immense effort needed for this undertaking was well worth while, because it enabled use to be made of redundant high-pressure equipment at Billingham for the conversion of propylene to isopropanol and also for use to be made of the facilities already existing for the bulk shipment of refined petrol. Once it was decided to hydrate propylene at Billingham it became logical also to install new plant for the conversion of isopropanol to acetone on the same site.

Erection of all the plants in the petroleum chemicals complex was carried out by or under the control of the Wilton works construction organisation. The olefine plant was designed and engineered by the M. W. Kellogg Co. Low Temperature Developments Ltd., London, designed and engineered the refrigeration sets for the ethylene oxide plant, while the evaporators on the glycol plant were designed and engineered by George Scott & Son (London) Ltd.

Coal Utilisation Research

THE British Coal Utilisation Research Association works to improve the efficiency with which coal is used under all circumstances. Current investigations, both in the industrial and domestic field, are described in their recently issued Annual Report for 1951. In view of the present shortage of coal and declining alternative fuel supplies, this work is of immediate economic importance in combating rising production costs and of significance in the future conservation of coal and hence other raw material resources.

Chemical studies

In the chemical programme a fairly radical change has been made with respect to the organic chemical side. The earlier programme on tar distillates has been entirely closed down. The objective is now to seek methods of using coal for chemical purposes in more direct ways than through carbonisation; the first method of attack is through solvent treatment. The conception of coal as a parent chemical is neither new nor academic. The world, more than it realises, has come to rely upon oil for many essential substances besides fuels; this country has no oil and the U.S.A. may be within a few decades of the exhaustion of its own natural resources. It is not envisaged that direct chemical uses would necessarily consume very much more than 1,000,000 tons p.a. of coal, but the potential importance to future chemical industry is considerable while the economic advantage to coal winning may be important.

At least four researches have reached the stage of potential development; these are dealkylation of higher phenols, production of phthalic anhydride and other substances from phenanthrene, production of zircon refractories and carbon and other products with the help of coal-solvent binders. In the coming year it is intended to accelerate the mutually related programmes on coking mechanism, active carbon and chemical utilisation.

Utilisation of coal for non-fuel purposes

Immediate industrial applications for coal-amine solvent mixtures, mentioned in earlier reports, have now been fully described to members. The basic principle of most is the formation, on heating to about 300°C., of a hard and hydrophobic compound of the coal and solvent, probably with elimination of water. Possible uses not previously mentioned are in the preparation of water-repelling surface coatings, *e.g.* to promote dropwise condensation in steam condensers, and (for solid coal extracts) in the carburising of steel. Work is in hand on the production of dense carbon bodies, such as electrode carbons.

Tests on the use of carbonised coal extracts as fillers for rubber, in place of carbon black, are in progress. The extract after removal of solvent is ground and then carbonised while fluidised in a stream of nitrogen.

The long-term programme concerned with development of coal as a chemical raw material has now reached the stage at which the immediate effort is concerned with physico-chemical separations. Fractionation of solutions of coal in amine solvents, and of humic acid solutions, is being continued, the principal methods used being electrophoresis and chromatography. To make full use of the results obtained, it is intended to employ the infra-red spectra of the products as a means of following the separations. Work has also begun on the measurement of osmotic pressures and on the examination of solutions in the ultracentrifuge.

Liquid phase treatment with atomic chlorine (produced by adding sulphuryl chloride and benzoyl peroxide), of unfractionated coal extracts suspended in chloroform, has been repeated on a larger scale in the laboratory, and has yielded 50 to 60% of chlorinated products soluble in chloroform, many of which are volatile, together with a somewhat smaller amount of soluble chlorinated material; the chlorine uptake was 25 to 45% of the weight of extract, according to conditions. The products appear to have no activity as insecticides, but may prove useful as a source of chlorinated waxes for electrical insulation and in other applications where a non-inflammable material is required.

The slow partial oxidation of coal is now being examined with the object of obtaining a complete material balance for the process, including forms of oxygen in the solid product. This work is intended to provide a firm background for studies in the chemistry of humic acids.

Refractories

Further work on zircon refractories has not been undertaken, but the exploitation of B.C.U.R.A.'s inventions is being actively pursued in collaboration with a member firm.

A coating for the metal walls of a cyclone combustor, to give protection from slag attack and assist in the building up of a stable slag layer during operation, has been developed. The chief ingredients are potassium felspar, borax and zircon, the mixture having approximately the same coefficient of expansion as the metal. Coatings of this type may have wider uses in industry.

Boilers and furnaces

The extensive scheme of boiler experiments which, notwithstanding statistical planning, has continued over several years, is nearing the end of its first phase—the study of fuel factors in relation to efficiency—and during 1952 another phase will start, namely the study of firing appliance

factors. In the furnace programme the salient problem has been to determine ways of producing clean hot gases in a cyclone combustor burning fine coals. At the same time assistance to industry in applying the *Downjet* furnace has continued.

Gas producers

The work on the automatic control of gas producers is the present culmination, but by no means the completion, of efforts made over several years to improve practice in respect of the coal-fired producer so that coal may compete more favourably with imported fuel for the steel and glass industries. The case for helping these industries to avoid becoming dependent on imported fuels could never have become so strong as in the latter part of 1951.

Coal gasification

A programme of work has been started on the gasification of low grade fuel, in fact several different bodies are engaged in studies of gasification. The gas industry seeks to relieve its dependence upon good coking coals for making gas; on the other hand the chemical industry is concerned with the economic production of gas of suitable H_2-CO ratio for chemical synthesis. The aim of B.C.U.R.A. gasification research is to find ways of using the less amenable, and even the unsaleable, coals.

Pelleting

An outstanding achievement in connection with low grade coals during the year has been the discovery of simple ways of converting raw colliery slurries into hard particles of uniform size. The process, described as ' pelleting,' consists in forming spherical particles of $\frac{1}{8}$ to 1 in. diameter by feeding the slurry over a shaker table of special surface contour. Advantage is taken of the binding property of clay materials present in the slurry so that no binder need be added. When dry the pellets are strong enough to survive moderate handling, do not disintegrate in a producer fuel bed and have given promising test results on a mechanical stoker firing a boiler. This is a development that has aroused great interest and steps are being actively taken by the gas producer department and appropriate departments of the National Coal Board to apply it on a substantial scale as early as possible.

Power stations

The programmes of field work at power stations on external boiler deposits, corrosion and dust sampling, as well as the work on coal grindability, have continued through the year. Field studies have been closely linked with fundamental studies in the laboratories.

Departmental liaison

Notwithstanding the broad division of work under headings of industrial and laboratory research there are many links between the two within the Association. The furnace department, for example, in its efforts to develop a cyclone combustion chamber for burning fine coal is beset with a major problem in the cleaning of hot gases intended for a gas turbine, and in this is being assisted actively by the physics department engaged in studies of the fundamental mechanics of particles generally; the domestic appliances division, seeking practical ways of burning coal smokelessly in appliances is aided by the combustion department engaged in fundamental studies of smoke formation and coal combustion; the *x*-ray section of the chemistry department is applying its techniques to the elucidation of the structure of water-tube boiler deposits in the aid of the combustion department which is investigating problems assigned to it by the boiler availability committee.

Extra-mural research

The contract undertaken for the Department of Scientific and Industrial Research on the development of a cyclone combustion chamber for burning fine coal was continued through 1951 in contact with staff of the Fuel Research Station and of the Ministry of Fuel and Power. The second experimental combustor completed earlier in the year has been tested extensively. Although the first objective is to meet the needs of a gas turbine of specific size a further important one is to test the prospects of the cyclone furnace as a consumer of low grade fine coals.

A research team is being maintained at the University of Sheffield under the direction of Prof. R. J. Sarjant. The initial programme comprised a study of the heat measurement problems related to the work in progress in the boiler department at Leatherhead. Following completion of the work early in 1951, the team was assigned certain fundamental problems related to the newly extended programme of the gas producer department on the new methods of gasification. As a prelude to the commencement of these studies, a B.C.U.R.A. team partly from Sheffield, partly from Leatherhead, and led by Prof. Sarjant, visited various German gasification plants early in January.

At Leeds University, under Prof. A. L. Roberts, investigations of the mechanism of smoke formation and the mineral constituents of coal are being supported. The British Iron and Steel Research Association has continued to support the gas producer programme and the dust programme.

Correspondence

OEEC chemical engineering report 'glib and facile'

Dangers of specialisation

TO THE EDITOR

DEAR SIR, I feel that some further observations on the subject of the OEEC publication ' Chemical Apparatus in the U.S.A.' so comprehensively reviewed by Dr. J. M. Coulson in CHEMICAL & PROCESS ENGINEERING, September, may be of some interest.

Although of undoubted value in attempting to analyse the reasons for the leading position of the American chemical, petroleum and other allied industries in world economics, this report tends towards glib and facile generalisations and gives an impression of the American chemical industry as flowing with milk, money and standards.

Any survey of an entire national industry which makes an unreserved statement that ' Promotion to a better position is also according to merit, never according to age or seniority,' deserves to be viewed with a certain amount of suspicion.

The treatment of the dangers of specialisation is very superficial and no satisfactory solution is put forward. The hard fact is that high efficiency tends to bring with it a general lowering of individual standards, just as mechanical mass production is tending to replace the craftsman by the machine-minder. This trend is beginning to result in the degeneration of many so-called qualified chemical engineers into technicians with a superficial and specialised knowledge of certain facets of chemical engineering.

We in Europe, if we are to venture into the realms of mass efficiency, which it seems we must do in order to survive, should not squander our resources and allow our engineers to become technicians, but rather train a new category of advanced technicians and retain our very limited supply of chemical engineers in vital positions where they can make full use of their versatility and knowledge of fundamental principles which is the keystone of their training.

Although we have many lessons to learn, we cannot afford to be deluded into believing that we can follow blindly in the footsteps of our transatlantic neighbour with her incomparably greater resources of manpower and mass production experience.

D. L. SHAW

Regents Park, London.

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HEAT TRANSFER

Conduction; Heat transfer between fluids and surfaces; Fluidised beds; Heat exchangers; Boiling and condensation; Radiation; Gas turbines; Rockets; Induction heating; Analogue methods

By J. Moss, B.Sc.

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SINCE the last review of heat transfer in this series, the most important event in the field has been the General Discussion on Heat Transfer held in London in September 1951 jointly by the American Society of Mechanical Engineers and the Institution of Mechanical Engineers. Most of the 90 papers presented are dealt with in this review, the exceptions being a few which rather digress from the main theme.

Later sections of the review deal with rockets, induction heating, etc., but here the intention has been to be selective rather than fully comprehensive.

During the period under review, four books of particular interest to the chemical engineer have been published. 'Industrial Heat Transfer,' by Hutchinson,[1] consists essentially of direct-reading graphs for the solution of various problems, the data for which came mainly from Jakob, McAdams and Stoever. The book is clearly set out, and the equation from which each graph is derived is shown in each case, so the limitations of the results obtained should be clearly visible. Jackson[2] has compiled a handbook entitled 'Cooling Towers' which is the result of experience at Imperial Chemical Industries Ltd., and which sets forth clearly, for the non-specialist, the principles of design and operation of mechanical draught towers. 'The Science of Flames and Furnaces,' by Thring,[3] contains a large and comprehensive section on heat transfer which should be of considerable value. Finally, a second edition has been published of 'Introduction to Heat Transfer,' by Brown and Marco.[4]

Conduction

Rosenthal and Ambrosio[5] have described a new technique for the determination of the thermal diffusivity of solids, by measurement of the temperature variations at one point in a bar of the material, using two different heat source velocities. Powell[88] has indicated means whereby approximate values for the thermal conductivities of metals can be estimated from the more readily obtainable electrical conductivities. A radial heat flow apparatus for determining conductivities in the range 0.001 to 0.1 c.g.s. units has been detailed by Barr.[6]

An adaptation of the Forbes' bar method has been used by Hogan and Sawyer[7] to measure the thermal conductivities of metals at high temperatures up to 1,000°C.

Several papers have appeared relating to insulating materials. Allcut[131] has analysed the effects due to radiation and convection in commercial porous insulators and Somers and Cyphus[8] have analysed the errors obtained in measuring the conductivity of these materials, as also have Clarke and Kingston.[9] Measurements on laminated plastics and other anisotropic materials have been carried out by Freiling, Eckert and Westwater[10] in which they found that the ratio of directional conductivities may be as high as 6: 1.

A theoretical approach to the problem of the thermal conductivity of soil has been attempted by Gemant[11] and reasonable agreement has been obtained with published practical results. Griffiths and Hutchings[85] have measured the heat transfer between buried pipes and frozen and unfrozen soil. Conductivities of various materials including soil have been measured by Griffiths and Hickman.[87] Keyes[12] has measured the conductivities of N_2—CO_2 mixtures, and has summarised the present data on the conductivities of He, A, H_2, O_2, N_2, CO, CO_2, water and air. The variation of the conductivity of air with temperature from −183° to 218°C. was determined by Kannuluik and Carman.[13] Rubin[14] has calculated the Prandtl number of steam from 200° to 1,000°F., using recently obtained data. Measurements of the conductivities of fluid argon and nitrogen were recorded by Uhler,[15] and measurements on liquid sodium and potassium by Ewing, Grand and Miller.[16]

Heat transfer in gun barrels has been investigated experimentally by Schmidt,[77] who showed the extreme temperature conditions which the inner skin of the barrel has to withstand, and Hicks[82] has given a theoretical treatment of this matter. The thermal conductances of metal surfaces in contact have been measured by Cetinkale and Fishenden,[80] the results obtained agreeing well with theory.

Heerden[84] has investigated theoretically the problem of unsteady heat flow in connection with the air cooling of collieries.

Three papers detailing mathematical solutions of problems that are of interest were: Plunkett,[17] 'A Method for Calculation of Heat Transfer in Solids with Temperature Dependant Properties'; Allen and Severn,[18] 'The Application of Relaxation Methods to the Solution of Non-Elliptic Partial Differential Equations' and 'The Heat Conduction Equation'; and Anthony,[132] 'Temperature Distribution in Composite Slabs.' A paper on the fundamental physics of heat conduction, by Eshelby,[79] gave a description of the picture theoretical physics ascribes to the mechanism in metals and insulators at normal temperatures.

Heat transfer between fluids and surfaces

There are half a dozen or more interesting papers having a fundamental theoretical approach to this problem. Perhaps the most important is that by Corrsin.[19] He examined the problem of heat transfer in a stationary isotropic turbulence with a constant small temperature gradient, and obtained an expression for the heat transfer coefficient depending on velocity field. Bosanquet[65] derived a formula for the correlation of heat and matter transfer with pressure drop, in the cases where both eddy and molecular diffusion were of account. The concept of a 'friction temperature' analogous to the 'friction velocity' was introduced by Squire.[69] Hinze and Hegge Zijnen[71] investigated the temperature distribution in the wake of a hot wire located in a free plane jet. Miyushina[72] has obtained a semi-theoretical equation for the heat transfer coefficients in annuli by means of the analogy between heat transfer and fluid friction. Different conceptions of the mechanism of eddy diffusivity were discussed by Taylor.[73]

Sugawara and Michiyoshi[20] have analysed by three different approximation methods, the heat transfer by natural convection on a vertical flat wall. Some interferometric studies on the stability and transition to turbulence of a free-convection boundary layer have been carried out by Eckert and Soehnghen[120]; one of their photographs is shown in Fig. 1.

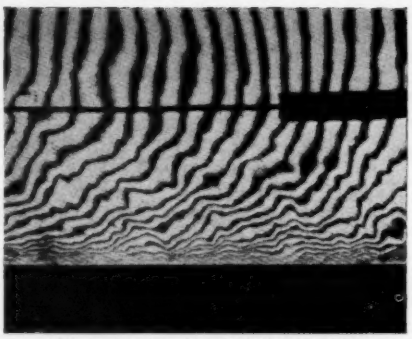
Seban and Shimozaki[21, 122] have in-

vestigated the heat transfer to a fluid flowing turbulently in a smooth pipe with walls at constant temperature. Codegone[88] has determined the air convection coefficient in pipes from 400 to 700°C. The effect of pulsations on heat transfer in pipes has been examined by West and Taylor,[22] who found that the water film coefficient at Re from 30,000 to 85,000 could be increased as much as 60 to 70% by the use of pulsating flow from a reciprocating pump.

Prins, *et al.*,[23] have given a rather academic treatment to the problem of heat transfer in laminar flow between parallel plates. A very comprehensive series of papers on temperature and velocity gradients, and eddy viscosities and conductivities, in turbulent flow between parallel plates, was presented by Corcoran, *et al.*[24] Linacre[56] has measured the heat transfer in jets of water impinging on metal surfaces, and Friedman and Mueller[125] have made measurements with a heated horizontal plate cooled by vertical jets of air impinging on it from various holes, slots and nozzles. Brun and Plein[25] briefly discuss their results obtained for heat transfer coefficients between an air stream and an electrically heated tube parallel to the flow, with Mach numbers from 0.35 to 2.95, and Kaye, *et al.*[124] have measured recovery factors and friction coefficients for supersonic flow of air in a tube. The distribution of the heat transfer coefficient around cylinders in crossflow at Re from 20 to 500 has been examined by Eckert and Soehnghen,[26] while Thomson, *et al.*,[66] have carried out similar work with Re from 6,000 to 23,000. Work on the air convection losses from horizontal cylinders at very low wind speeds, more particularly different types of overhead power lines, has been reported on by Hutchings.[56]

Experimental investigation of local coefficients in straight rectangular fins was reported by Ghai.[67] The heat transfer and pressure drop in banks of finned tubes and laminated coolers have been measured by Schmidt,[70] and the application of finned surfaces to radiators for aircraft was discussed by Still.[109] Weiner, *et al.*,[128] have determined the local boundary conductances for an unbaffled circular finned cylinder, and the behaviour and application of compact high-performance heat transfer surfaces, have been examined by Kays and London.[123]

Three papers dealing with heat transfer to low-pressure gas are of interest. Stalder, *et al.*,[126] carried out tests on a cylinder in an Ames low-density wind tunnel and discussed their results and others, while Drake and Kane[121] have measured the heat transfer to spheres and plates in high-speed rarefied gas streams. Madden and Piret[135] have investigated the free convection heat transfer from wires at low pressures. Their theory takes into account the temperature discontinuity which develops at the gas solid interface with decreasing pressure.



[*Photo: American Society of Mechanical Engineers*

Fig. 1. Turbulent flow; interference lines indicate temperature profiles.

Five papers appeared in the 'General Discussion on Heat Transfer' relating to liquid metals. Trefethen[104] measured the heat transfer of Hg in circular tubes and annuli and concluded that wetting of the wall was unimportant, whereas Cope[111] considered that it probably had an effect. The heat transfer properties of Hg were also considered by English and Barrett,[112] who proposed that the removal of dirt films, and not wetting, was the real effect of the wetting agents. Gilliland, *et al.*,[139] cast doubt on the validity of any correlation neglecting the effect of cross-sectional density variations due to heat flux. Heat and momentum transfer in the turbulent flow of Hg have also been investigated by Isakoff and Drew.[140]

Fluidised beds

Measurements of heat transfer coefficients in fluidised beds have been carried out by Walton, Olson and Levenspiel[27] with coal beds and Dow and Jakob[28] with *Aerocat*, pitch coke and iron. Heerden, Nobel and Krevelen[29, 95] have correlated their results obtained with carborundum, coke, iron oxide, lead, etc., using various fluidising gases, and Leva[142] has made measurements with sands, Fischer-Tropsch catalysts and silica gel particles and has reviewed the present theories on heat transfer in fluidised beds.

The effect of having the tube in either a vertical or horizontal position was investigated by Vreedenberg,[101] and in a later paper[30] he discussed the results obtained with a vertical tube and fluidised sand. The heat transfer between fluidised cold quartz sand and hot air has been measured by Khudyakov and Chuckanov,[31] who correlated Nu and Re numbers. In a mathematical analysis, Carr and Amundson[32] came to the perhaps unsurprising conclusion that without heat generation intraparticle conduction could be ignored. The fundamental relations between the average and local surface heat transfer coefficients, flow resistance and flow rate, for a bed of randomly packed spheres, have been examined by Denton.[100]

Regenerators

The subject of regenerators was dealt with by three papers in the Institution of Mechanical Engineers' discussion. Davies and Singham[103] have carried out experiments on a small thermal regenerator; Schultz[106] has made a theoretical analysis of a regenerator with longitudinal heat conduction and a more general paper on regenerators was presented by Saunders and Smoleniec.[107]

Heat exchangers

In a paper by Holfelder[33] on measurements on heat exchangers, the basic principles were discussed and means of instrumentation reviewed. A very comprehensive and detailed analysis of the shell side characteristics of shell and tube heat exchangers was given by Tinker,[120] in which he examined the fluid flow pattern, co-ordinated performances of several test exchangers on the basis of 'effective flow areas' and examined the effect of dimensional characteristics and mechanical clearances on performance. Smith[58] discussed some performance factors in the design of heaters and coolers for the heavy chemical industry, and the service efficiency of a simple tubular heat exchanger in the brown-coal tar industry was described by Kayser.[114] An exchanger employing rotating blades inside the transfer tube, to increase the transfer coefficient and prevent localised overheating, for use in the food industry, was described by Bolanowski and Lineberry.[34] Measurements on heat exchangers and chillers for the filter feed in solvent dewaxing plants have been made by van Altena and de Haas.[110]

Cameron[74] has done some preliminary investigations into the problem of heat transfer in journal bearings. Peregrine and Rowland[75] have described how successive layers of cooling air streams may be substituted for normal static insulation, with the object of reducing weight and volume. Heat transfer coefficients in two-phase (gas-liquid) flow have been measured by Verschoor and Stemerding[76]; they found the coefficient to be a maximum at the transition point between slug and annular flow.

Heat transfer to viscous materials in numerous industrial processes was discussed by Perry and Reese.[35]

Boiling and condensation

The mechanism of boiling heat transfer has been studied by Rohsenow and Clark[36] and was also the subject of the following papers. Farber[37] has measured the heat transfer coefficients from Cu and Fe wires to water between 0° and 100°C. with wire temperatures up to their melting points. A method for the rapid determination of transfer coefficients in boiling liquids was described by Weil,[38] and Weil and Lacarze[39] have also carried out measurements on hydrogen boiling under atmospheric pressure. Boiling transfer coefficients for *Freon*-12 in a vertical tube in the pressure range 0.0801 to 0.241 atm. have been determined by Yoder and Dodge,[113] and

Brown[59] has analysed the cyclical heat interchanges between charge and cylinder in a refrigerator compressor operating on *Freon* 12. A theoretical analysis of the fundamentals of boiler circulation by Haywood,[62] although not directly concerned with transfer coefficients, was of interest in this problem.

The evaporation of a liquid drop braked by air was theoretically analysed by Sjenitzer.[61] Experiments were carried out by Richardson[63] on drops suspended in a wind tunnel and he concluded that the Re of the flow as well as that of the drop was of significance. A critical comparison of theoretical and practical results for the cooling of a freely falling water drop was given in the paper by Snyder.[129] A description of the design of a mechanical water cooler has been given by Walker.[55]

Both dropwise and filmwise condensation of steam on a metal surface have been investigated by Hampson[60]; the results agree well with Nusselt's theory in the case of filmwise condensation, larger coefficients constant over a large range of heat loads being obtained with dropwise condensation (see Fig. 2). Peck and Reddie[10] have given experimental results for the heat transfer coefficients of vapours condensing on horizontal tubes, which show considerable deviation from those calculated using the Nusselt equation. By rejecting two of Nusselt's basic assumptions, they derive their own correlation, which they claim fit more nearly their results and those of 16 other workers. The opposite conclusion was arrived at by Short and Brown[117] in their investigation of a bank of 20 horizontal tubes. They found that the average coefficient agreed well with that predicted by the Nusselt theory for the top tube.

The effect of vapour velocity on condensation, and liquid film turbulence, inside tubes has been examined by Carpenter and Colburn.[116] Condensation of benzene in the presence of air was the subject of a paper by Smith and Robson.[119] Weinberg[11] has given a theoretical solution for the temperature difference existing in the steam heat transfer to very small drops of water. The problem of the condensation of steam on water drops was the subject of experiments by Brown.[57] Spoendlin[12] has described a counter-current hydrogen or helium liquefier. Condensation of air in supersonic wind tunnels was investigated by Stever.[127] Beatty, *et al.*,[14] have used an enthalpy driving force concept in their examination of heat transfer from humid air to metal under frosting conditions. Crystallisation and heat transfer in a stream of liquid metal flowing along the surface of a mould have been investigated by Fell.[81]

Radiation

The Flame Radiation Research Joint Committee has published its reports of the 1949 Ijmuiden trials.[43] The trials were carried out on their 24-ft. experimental furnace. The reports included

[Photo: Institution of Mechanical Engineers

Fig. 2. Ideal dropwise condenser.

a review of previous work on luminous radiation, design of heat flow meters and pyrometers, a description of the main experiments and conclusions drawn from the trials. Thring[89] has also described the heat flow meters, and Ribaud, *et al.*,[92] gave a brief description of the trials and their conclusions. Two more interesting papers by Thring have appeared. The first[44] was concerned with a theoretical analysis of the temperature distribution along a radiating gas stream in which heat was generated by a chemical reaction; the second[45] was on the effect of emissivity and flame length on heat transfer in the open-hearth furnace. Berenblut[91] discussed the emissivity of the cloud of carbon particles causing luminosity in fuel oil flames. A brief paper on heat transmission in furnaces was given by Sarjant and Smith,[94] and a much more detailed paper on this subject was later presented by Hulse and Sarjant,[46] in which one of the conclusions was that, except at the lowest temperatures and beam lengths, gas radiation plays an important part in many furnaces employing so-called forced convection heating. Calculations on heat transfer to grate bars have been given in the paper by ter Linden.[98] The third article on radiation from diatomic gases by Penner, *et al.*,[47] was concerned with numerical emissivity calculations for CO at low optical densities. Guyomard[48] gives his conclusions on measurements carried out on the total radiation of coal gas flames, but no detailed results were presented. Heat and mass transfer in combustion of liquid fuels, in an air stream, on a cylindrical surface, have been investigated by Spalding.[90]

Emissivities of metals and pure refractory oxides at varying temperatures were measured by Sully, *et al.*,[49] and the effect of particle size examined. Bacon and James[93] have determined the emissivities of refractories and molten steels. Glass mat surfaces as radiant heaters in ovens and driers have been tested by Broughton.[134]

Gas turbines, I.C. engines, and rockets

A gas turbine rotor employing water cooling by natural convection at high centrifugal acceleration, developed during the war at Braunschweig-Völkenrode, has been described by Schmidt.[96] A comprehensive review of different cooling methods for gas turbine blades, and the respective heat transfer theories, is given by Ellerbrock.[141] Brown[102] has examined the effect of the radiation correction on cooling loss in high-temperature cooled gas turbine blades, and showed that the effect is relatively small. The problem of the turbo regenerator as applied to gas turbines has been discussed by Hryniszak.[113] Effusion cooling of sintered metals was investigated by Grootenhuis, *et al.*,[97] and more particularly with respect to turbine blades by Staniforth.[108]

Heat transfer in internal combustion engines was the subject of papers by Alcock[105] and Taylor.[138] Another contribution to the controversial subject of the importance of chemiluminescent radiation in I.C. engines has been made by Baker and Laserson.[136]

Ziebland[99] has proposed a method for determining the heat flow densities in rocket motors.

Induction heating

In his paper on temperature distribution with simultaneous platten and dielectric heating, Nelson[50] considered the optimum conditions for thermosetting resins, etc. The low-frequency induction heating of high boiling point liquids, vapours and fluidised beds has been discussed by Bleloch[64] and particulars of suitable types of heater given.

Analogue methods

Electrical analogies for the solution of various heat transfer problems are being more widely used. An electrical circuit for the solution of unsteady heat flow problems was described by Price and Sarjant.[83] Brokmeier[51] has used the electrical analogue suggested by Beuken for the solution of a number of problems, including oven insulation, temperature distribution in soil, walls and motors, and heat exchangers. The thermal behaviours of houses and dwellings have been studied by Burnand,[52] using an electrical analogy technique. A brief discussion on the solution of the temperature distribution in solid bodies with various boundary conditions using Dusinberre's computational method and an electrical analogy has been presented by Williams.[53] Jenkins, *et al.*,[54] using an analogue computer and generalised equations of fluid mechanics, calculated temperature distributions in turbulent flow, and compared them with experimental results. Schlinger, *et al.*,[127] have also presented their results on the same problem.

An electrical analogy was used by Kayan[130] in the solution of heat exchanger problems, where complications arose due to varying overall specific heats and conductances, *e.g.* where both radiation and convection exchange were present on one side of the system. An experimental air flow analogy unit for the solution of transient heat conduction problems has been described by Coyle.[78]

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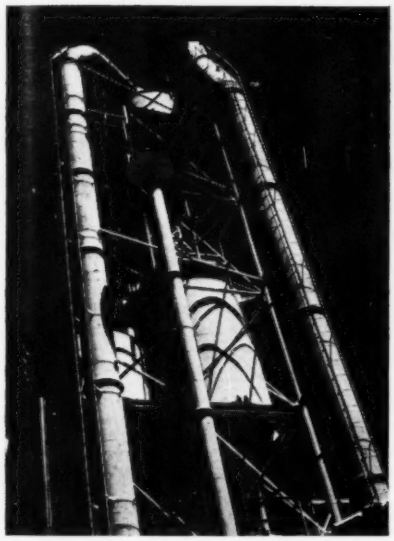
Gas law deviations. Institute of Gas Technology Research Bulletin No. 13, ' Measurement of Gas Law Deviations with Bean and Burnett Apparatus,' by O. T. Bloomer, is now available. The bulletin presents a comparative study of the Bean and Burnett apparatus as to accuracy and reproducibility in determination of deviations from the ideal gas law, and ease of operation in obtaining this data and in calculation of the results.

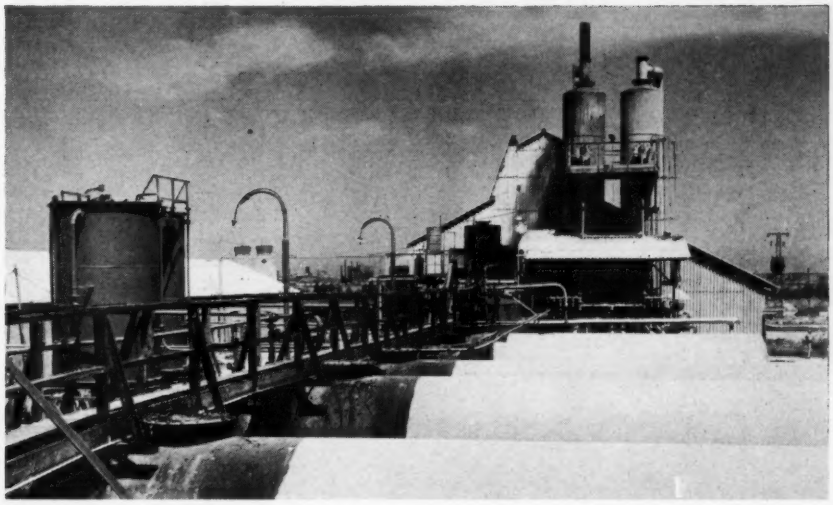
Cooling towers. Induced-draught counter-flow cooling towers made by Foster Wheeler Corp. are described in the company's bulletin CT-52-4. Included in the range are towers constructed from redwood, concrete, brick, steel and asbestos. The water distribution system employed is either of the spray nozzle or gravity type. Decks of fill retard the fall of water through the tower. They break up each drop of water and permit it to combine with others to form new drop surfaces for additional cooling by upflowing air.

New Fertiliser Plant will Supply all Israel's Needs

Scheduled for completion in 1954, a new I£12 million fertiliser plant is being built at Haifa by Fertilisers & Chemicals Ltd. It will produce all Israel's requirements of fertilisers and provide local industry with important heavy chemicals. The plant is designed to produce nearly 300,000 tons p.a. of six different fertilisers, besides certain basic chemicals. Below is a description of the project.



Part of the superphosphate plant.



(Right) **The sulphuric acid plant; an additional unit is now under construction. The Haifa oil refinery installations and cooling towers can be seen in the background.**

THE total investment in the new plant of I£12 million includes the equivalent of $7 million in foreign currency. Imperial Chemical Industries Ltd. have invested I£437,000. Other shareholders are the Israeli Government, Palestine Potash Ltd., Palestine Economic Corporation (U.S.A.), Palestine Jewish Colonisation Association, Africa Palestine Investments Ltd., Hamashbir Hamerkazi Ltd., Canada - Israel Developments Corporation Ltd. and S. Africa Joint Enterprises Ltd.

The plant has been designed by European and U.S. companies. The sulphuric acid and ammonia plants have been designed by the Chemical Construction Corporation, New York. The nitric acid plant has been designed by the Société Belge de l'Azote. The superphosphate plant has been built by Etablissements Kuhlmann, France, and is now in operation, supplying up to 30% of Israel's requirements.

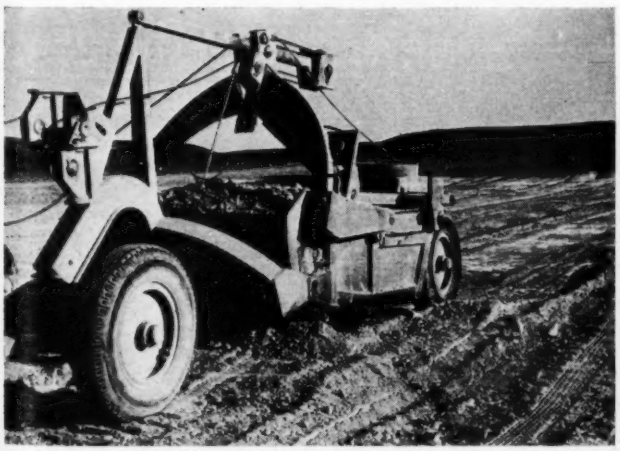
Output

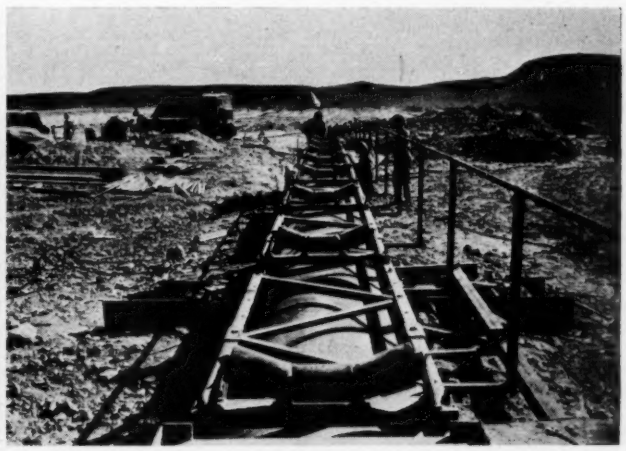
The individual units are being designed to produce 150,000 tons single superphosphate, 50,000 tons ammonium sulphate, 45,000 tons ammonium phosphate, 15,000 tons potassium sulphate, 8,000 tons di-calcium phosphate and 7,500 tons ammonium nitrate p.a. Actual output will, however, be varied to meet market requirements.

When operating to designed capacity the plant will require annually 14,000 tons ammonia, 85,000 tons sulphuric acid, 25,000 tons phosphoric acid and 14,000 tons nitric acid, all of which will be produced on the spot.

The main raw materials will be obtained

(Concluded on page 613)





The Negev phosphate rock deposits. *(Left)* **Removing the top layer to uncover phosphate rock.** *(Right)* **Conveyor belt under construction.**

At this year's annual meeting of the British Association held in Belfast, the training of chemical engineers was discussed in two papers presented to the Engineering Section. Prof. D. M. Newitt discussed the place of chemical engineering in higher technological and technical education, and Dr. E. H. T. Hoblyn spoke of the national importance of chemical engineers and their further training in industry. These two papers appear below, followed by a report of Sir Harold Hartley's remarks in opening the subsequent discussion.

The Training of Chemical Engineers

By D. M. Newitt, D.Sc. F.R.S.

(*Professor of Chemical Engineering, Imperial College, London University*)

THE rise of chemical engineering as a primary technology is one of the direct consequences of industrial and economic developments which are still taking place. It may be said to owe its origin to the big expansion in the heavy chemical industry and to the simultaneous growth of new industries, resulting from intensive scientific research during the latter half of the 19th century. There was at that time a growing conviction that empirical methods of plant design, based largely upon trial and error, could no longer meet the needs for better process control and for higher operating efficiencies and would have to give place to more scientific procedures. George E. Davis, one of the pioneers of chemical engineering, first began to lecture on the subject in 1887, and his well-known 'Handbook of Chemical Engineering' was published in 1901. The introductory chapters of this book will deserve to be studied by anyone in doubt as to the true functions of a chemical engineer.

The new branch of engineering, however, made slow progress in this country and, as has so often happened, it was left to Germany and America to build up those renowned schools of chemical technology and chemical engineering which, during the inter-war years, gave them such an outstanding lead in the international race for higher industrial productivity. We now have to face the task of recapturing some of the lost ground and, by increasing our facilities for higher technological education and vocational (technical) training, of making available to industry the skilled men required, at all levels, for the purpose.

But, in the interval, the picture has changed and the problem has increased in scope and complexity. Technological, economic and social factors are now so closely interwoven in the structure of the modern state that higher technological education must aim at providing not only for the vocational requirements of the technical specialist but also that wider culture essential to those destined for leadership in industry and commerce. It is in this broader context that the training of chemical engineers should be considered.

Perhaps the best approach to the subject is by way of a statement of objectives based upon the needs of industry and the exigencies of the present economic situation. There is a great deal of evidence to suggest that our industries have, over the course of years, lost the initiative in the development of new processes and products; and numerous examples might be quoted in which inventions and discoveries made by our scientists have been left for exploitation abroad. The growing practice of paying royalties to our competitors on this count is, in every respect, undesirable; not only is purchased 'know-how' always out of date, but the practice denies to our technologists those opportunities for widening their experience and displaying their skill and initiative which are so necessary if we are to compete on level terms in the world's markets.

To meet this situation requires combined action by industry and the schools. The objective of a chemical engineering training is, in the words of Prof. W. K. Lewis, 'The development of the capacity of the student when faced with a new and unfamiliar situation, to handle it with a competence, involving skill, initiative and leadership.' Industry must ensure that, when such men are available, opportunities are offered for the exercise of their talents; its responsibilities, however, do not end here and reference will be made later to ways by which it may with advantage make a contribution in the educational field itself.

It may be well, at this stage, to dispose of certain misconceptions which exist in regard to the nature and scope of a chemical engineering curriculum. In the first place, it must be recognised that the subject constitutes a distinctive discipline which embraces the whole of that body of applied science utilised in transferring a process from the laboratory stage to large-scale production; it is, in addition, concerned directly or indirectly with the economics of production and with the social implications of new scientific discoveries. The range of subjects to be covered is, therefore, extensive and any endeavour to insist upon a high degree of proficiency in all the sciences included in the definition would be impracticable. A thorough grounding in the fundamental principles of the physical sciences is essential but attention should, thereafter, be directed towards those special applications which constitute what are now generally known as the unit operations and unit processes of chemical engineering.

It will be clear from these considerations that endeavours to base a first degree course in chemical engineering upon any synthesis of existing courses in chemistry, physics and mechanical engineering are unlikely to be successful. The only feasible compromise is that by which chemical engineering may be taken as a post-graduate subject following upon a first degree in chemistry or mechanical engineering; this method, however, involves an additional one or two years of study and carries with it no very tangible compensating advantages.

Works experience

From the educational point of view, one of the important problems common to all categories of technology is the emphasis which should be given to works experience as an integral part of a university training. The purpose of introducing a student to industrial life during his university career is to impress upon him at an early stage that this work has to form part of a complex structure, other component parts of which are labour and management. Up to a point, this can be done by instruction in the principles of industrial management and in the economics of production, but nothing can replace the first hand experience gained by direct contact with men and things.

Two alternative methods have been adopted to this end in this country, the one based upon vacation work and the other upon sandwich courses; in the former, the student is expected to devote some eight weeks of at least two long vacations to employment in a works; in the latter, more extended periods of employment are sandwiched between attendance at the university. There is not much to choose between the two and both depend for their success upon the student's being able to identify himself with the routine and life of the works and being given definite duties and responsibilities. In all circumstances, he will pick up something of value from such industrial contacts and, when the courses are carefully planned, the benefit he obtains is important and far-reaching.

In general, first degree courses in chemical engineering extend over three post-intermediate years, the first two of which are devoted to the physical sciences and to certain branches of mechanical engineering

and mathematics and the final year to unit operations and processes. It cannot be held that such a short period is sufficient to enable any comprehensive syllabus to be covered in its entirety, and it is particularly important to guard against the dangers of introducing so much detail that the student fails to obtain a broad perspective of his subject. For this reason, an extension of the course to a fourth year, with all the formal apparatus of lectures, tutorials and examinations, is not altogether desirable. The atmosphere of impending examinations is not conducive to independent thought and inquiry; and, if we wish to foster and develop initiative and enterprise, there must be a period during which the student can, under direction, begin to apply his knowledge. In some respects, this end is attained by one or two post-graduate years devoted to original work. In the case of selected students the time so spent is undoubtedly of great value. The planning of a systematic piece of research, the devising of new experimental methods and techniques, the critical appraisal and discussion of results bring out qualities in a student which no system of examinations can hope to reveal. But it must be recognised that all students are not temperamentally or intellectually fitted for research work and no useful purpose is served by forcing them to spend one or two years in a distasteful occupation.

A more practical post-graduate course

If we remember, however, that the technologies aim at the application of fundamental principles to practical problems and at the introduction of new methods and techniques into industrial practice, it becomes possible to devise a post-graduate course which will entail investigations of a more practical character than those generally included under the heading of fundamental research.

There is no reason why such investigations should not, in suitable circumstances, be undertaken by teams of students rather than by individuals and in co-operation with industry rather than in the isolation of a university laboratory. This matter has been referred to indirectly in the Cremer Report on Chemical Engineering Research, which emphasises the importance of the functional analytical approach to chemical engineering research.

As the result of such a system of training, the graduate should enter industry with a background of fundamental science, with some knowledge of industrial organisation and with a sound understanding of the basic operations of chemical engineering. He will not be familiar with the practice of any one industry nor with those technical details of plant operation which can only be acquired by works experience; and it must be recognised that some time will elapse before he can be expected to make his full contribution as a technical specialist. He should, however, be competent, at the outset, to undertake design and development work and to bring to it those qualities of initiative, originality and adaptability which are so urgently needed in industry today.

Finally, it will be evident that chemical engineering differs essentially from those technologies which are confined to the principles and practices of particular industries or of groups of related industries and that chemical engineers can, by the generality of their training, be regarded as a mobile force of technologists able to move from industry to industry as economic conditions dictate.

The Chemical Engineer in Industry

By E. H. T. Hoblyn, M.B.E., Ph.D., A.R.C.S., F.R.I.C., M.I.Chem.E.

(*Director, British Chemical Plant Manufacturers' Association*)

IN any discussion on higher technological education it is necessary to consider, among others, two factors—the part which the technologist is to play in industry and the contribution which industry must make to his training. This paper is devoted to these factors in so far as they concern the education and training of a chemical engineer.

The growth of the chemical industry in Great Britain, in the United States, in Germany and elsewhere has brought with it the realisation that chemical engineering is no haphazard admixture of chemistry and engineering but a distinct technology in its own right—that it has, in fact, emerged as the fourth primary technology. Although comparatively young, the chemical engineer today stands shoulder to shoulder with the civil, mechanical and electrical engineer in contributing to the growth of the world's technological industries.

During and since the war there has been a rapidly growing awareness of the lack of technologists in the U.K. This shortage has resulted in others, notably the Americans, developing on a commercial scale the discoveries of our pure scientists and, as Sir Harold Hartley pointed out in his recent Presidential address to the Institution of Chemical Engineers,[1] 'know-how' and designs in certain fields have had to be obtained from abroad. This was not because of any shortcomings in our native skill and ingenuity, but because there were not available the appropriately trained men in sufficient numbers to enable us to do the development work ourselves with the necessary speed.

As was pointed out in the Dunsheath Report,[2] many Americans believe that their large numbers of chemical engineers have been an important factor in the rapid progress of industry in the United States. In 1949-50, the number of first degrees in chemical engineering in the U.S.A. was 4,529, to which must be added 712 Masters' and 178 Doctors' degrees. It is doubtful if the U.K.'s output of chemical engineers from graduate and post-graduate courses will exceed 250 in 1953. Dr. Dunsheath's team was impressed by the importance attached to chemical engineering in America and reported that this is a field to which American industry looks for a large and increasing number of its graduates.

It is not too soon, therefore, that so much attention is now being focussed on chemical engineering education in Britain. Before the end of the war industry was active in putting forward its views on this subject and was instrumental, with the very ready co-operation of the Ministry of Labour and National Service and the Ministry of Education, in establishing soon after the war short-term courses in chemical engineering to bridge the gap until more men were available from the normal university courses. These courses proved most valuable; they not only produced good men but many of them have since grown into full-time degree courses.

The work of the chemical engineer

Before discussing the part which industry must play in the training and utilisation of chemical engineers it is desirable briefly to examine the main types of work in which they find employment in the chemical and allied industries including the gas and oil industries. These are research, development and design of plant; construction and installation of plant; process control and plant operation; plant maintenance. The nature of the work, the type of man employed and the level of qualification required all vary from job to job and from section to section of the industry.

Chemical plant manufacturers use chemical engineers for research and for designing and installing plant and handing it over to the customer operating satisfactorily. Such work is fundamentally the same whether the plant is to be used in the chemical, gas or oil industries and requires to be carried out by fully qualified chemical engineers of high technical ability and preferably with

some plant operating experience. The plant manufacturer also employs chemical engineers on his sales staff. The chemical and allied industries employ chemical engineers in two very different spheres which require different levels of educational attainment in the subject.

In the first place the chemical industry uses chemical engineers for research and development and the subsequent design and installation of plant for its own particular processes. This often involves the linking up of specialist equipment supplied by a number of plant manufacturers. Such work may also include the costing of the plant and process and its comparison on technical and commercial grounds with an alternative process. A fully-qualified chemical engineer is required for such duties and he must be competent to work closely from the outset of the project, on the one hand with the chemist who has evolved the process in the laboratory and on the other with the civil, mechanical and electrical engineers who will be concerned with the erection and servicing of the plant and the structures which support it or the building which houses it.

The chemical industry also employs chemical engineers for plant operations and process control. Whilst large numbers are employed in this way, the number could be greatly increased with advantage to productive efficiency, if men with the right type of training were available in sufficient quantity; a lower level of training can normally be accepted for such work for which Higher National Certificate chemical engineers to whom reference is made later should be admirably suited. The oil industry and the gas industry, like the chemical industry, use chemical engineers for design and development work and for process control and technical supervision.

It is clear, therefore, that in the chemical and allied process industries and in the engineering industries which serve them, there is tremendous scope for chemical engineers of varying levels of competence and inclination. What, then, does industry require in their training?

The education of the chemical engineer

There has always been a close and mutually valuable relation between British industry and the universities; as a result courses in chemical engineering, as in many other subjects, are usually a sound blend of the ideas of academy and industry.

Opinions on the method of training a chemical engineer will obviously differ as they do in the case of the training of any other technologist. There is little doubt however, that the four-year undergraduate course to an honours degree is now accepted as the most usual form of training a top grade chemical engineer.

It is important to stress that the chemistry and engineering content of the courses leading up to the study in the final year of chemical engineering proper should always be planned with that end in view. Chemistry and engineering must be taught for chemical engineering and there must be no stuffing of the student with facts at the expense of fundamental principles. For example, there is no need for the student to be familiar with a wide range of complex organic syntheses but he should have a clear understanding of the functions of oxidation, reduction, esterification, saponification and so on in organic chemical processes, and of the wide applications of reactions, such as the Friedel-Craft and the Grignard, and the conditions under which they have to be carried out. Similarly, his engineering training should be directed towards a clear understanding of such questions as the flow of fluids, the transfer of heat, the strength of materials and its application to vessel design rather than towards, for instance, a study of mechanisms. It is to be hoped that eventually more of the early training will be given in the chemical engineering departments themselves.

Courses vary from college to college, and it is desirable that they should and that each college should build up its own tradition for producing a man with a certain type of training. Depending upon the nature of the work for which the new entrant to industry is required, so should the prospective employer be able to lean towards the products of a particular school of chemical engineering.

Originally, chemical engineering was taught as a post-graduate subject to graduates in chemistry, physics or engineering. Such courses still, and must, exist for the benefit of those who at a later stage in their academic careers decide to study chemical engineering rather than to proceed to research work in their subject of graduation.

The most significant advance which has been made recently in the scope of chemical engineering training is the establishment of Higher National Certificates in the subject; the courses to the H.N.C. will be taken by students holding a National Certificate in chemistry or engineering.

Industry should welcome these new courses which will produce what have already been described as the N.C.O.s of the chemical and chemical plant industries. It is for industry to ensure that sufficient raw material is forthcoming from its ranks to warrant the establishment of H.N.C. courses in various centres. It must also ensure that it uses these N.C.O.s properly; first, they should be employed at a level of work suited to their training—in some cases this should enable better qualified men to be released for more responsible duties whilst in others it should enable more chemical engineers to be used on duties for which at present they are sadly lacking, such as plant and process control as mentioned earlier. Secondly, industry must provide the N.C.O. with the incentive of promotion, where competent, to commissioned rank.

Care must be taken by those concerned that H.N.C. chemical engineering courses are not established in centres which are so close together that they compete for students. It is far better, initially, to have fewer courses and for those courses to be good and supported by properly equipped laboratories.

Industry's part in education

One of the comments made by witnesses to the Chemical Engineers' Sub-Committee of the Hankey Technical Personnel Committee was that ' Chemical engineering is essentially an applied science . . . The object of a university training should not be to turn out a ready-made chemical engineer, but to teach a man to think along the right lines so that after practical experience he can become one.'[3]

Industry, therefore, must make its contribution to the education of the chemical engineer by being prepared to train him further after he leaves the university. In this connection the graduate must come to industry in the proper frame of mind, and there is an onus on the teaching staffs to ensure that students do not leave the universities feeling that they are Heaven-sent gifts to industry. Some firms in the chemical plant field and elsewhere have developed two-year trainee courses for chemical engineering graduates which not only give the men extended training while employed but also enable the employer to determine the type of work for which a given individual is best suited. At the end of these courses the trainees are free to go elsewhere should they so desire.

In addition, industry must help the student while he is still at the university by providing facilities for vacation and sandwich courses. Understandably, there is a school of thought which prefers the student to do something totally different during his long vacation, but most students prefer to obtain practical experience at some time during this period.

Many firms now have excellent vacation training schemes from which the student can gain real benefit. It is imperative that firms accepting students for vacation work do so with a full sense of their responsibility in assisting in their training, and that close liaison is maintained between the firms and the students' professor. Examples of the type of work on which students can be employed are operational tests on plant or the carrying out of pilot scale work in connection with some research problem.

There is also good reason to devote one vacation to working on the shop floor. This does not mean that the student should spend hours learning to file flat or to operate some machine tool. He can, however, work on the assembly of plant in the shops, learning from this good and bad features of design; he can gain some knowledge of the foundry and its problems by working as a mate to a good moulder; physical operation of a plant which does not readily lend itself to modern methods of

automatic control will provide an experience the value of which cannot be lost. There is also a vitally important human aspect of this type of vacation work—it brings the student right alongside the workman; he learns something of his outlook on life, how he thinks, how he works out problems and above all he learns how to get on with him. Many first class technical men have failed in plant work because they possessed the unhappy knack of upsetting work people.

Works experience can also be obtained by sandwich courses which can be developed into something of real value to industry as well as to the student. The report of the Cremer Committee on Chemical Engineering Research pointed out the need to collect and analyse data from large-scale plant operation. Work of this nature could be carried out by a team of students working under appropriate guidance. There have already been cases on which students on vacation courses have carried out tests on plant, and the data they have collected has led to modifications resulting in greater efficiency of the plant. Investigations on the actual working plant planned jointly by the teaching staff of the university and the technical staff of the company concerned and carried out under supervision during the students' actual course should be developed on an increasing scale in this country. This use of industry as the chemical engineering laboratory has met with great success at the Massachusetts Institute of Technology, and there is no reason why it should not do so in this country.

Another and totally different aspect of the contribution which industry must make to the training of the chemical engineer concerns particularly the man working for the Higher National Certificate or other external qualification. First he must be so stimulated that he wants to become a chemical engineer. Then, once he has embarked on this course, those responsible for his work must take an active interest in his studies and by precept and practice indoctrinate him with their own trained methods of working. For such a man industry is his only university and therefore his boss must try to be his professor.

The future

Figures were published[4] in 1950 of the estimated future demand for chemical engineers, but in view of the expansion of Britain's technological industries and the ever-growing appreciation of the part which the chemical engineer can play in industry, these estimates may well prove to be low.

It is certain that facilities for chemical engineering training in this country will expand rapidly over the next few years, but at the same time there must be no relaxation of teaching or qualifying standards; in this respect it is fortunate that the Institution of Chemical Engineers has such a keen sense of its responsibility for maintaining the high standard so properly demanded by the profession.

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[1] CHEMICAL AND PROCESS ENGINEERING, 1952, 33, (6), 313.

[2] Productivity Report, 'Universities and Industry,' Anglo-American Council on Productivity, November 1951.

[3] Present and Future Supply and Demand for Persons with Professional Qualifications in Chemical Engineering,' H.M.S.O.

[4] *Ibid.*

Discussion

IN opening the discussion Sir Harold Hartley, immediate Past-President of the Institution of Chemical Engineers, said that both Prof. Newitt and Dr. Hoblyn had claimed that chemical engineering was a fourth primary technology. Was that accepted by the other engineers in Section G? In the historical sequence civil engineers were first in the field, then with the coming of the steam engine the mechanical engineers had developed their own specialised field, followed in turn by the electrical engineers, and now in the 20th century in addition to the great expansion of the chemical industry, chemical techniques had invaded most of the processing industries such as oil, food, wood and rubber. From this had developed, to quote Prof. Elgin of Princeton University, 'a distinct body of science which is fundamental and peculiar to chemical engineering. This involves principles, theories, procedures, methods and techniques fundamental to the majority of chemical engineering operations. While in some cases this body of science involves and utilises subject matter and principles common to other sciences, it modifies, extends, orients and combines these principles in a unique manner.' That was the basis of the claim of the chemical engineers for recognition of this new primary technology.

Both the previous speakers had pointed out that the function of the chemical engineer was the design, construction and operation of plant on an engineering scale based on laboratory research. He wished to emphasise that in this the chemical engineer is not aiming at self-sufficiency. Civil, mechanical and electrical engineers are all associated with this work and the chemical engineer in the large plant construction firms acts as the co-ordinator of the team. Chemical engineering, like other branches of engineering, was based on classical physics, as it was concerned with the transfer of mass and energy, and the decline in interest in classical physics due to the lure of nuclear physics and electronics might become a serious danger in the future.

Sir Harold then spoke of the increasing demand for chemical engineers, citing as an example the new industries in South Africa, and the urgent need to increase the output in this country. America is producing 5,000 a year as against 200 at home. Chemical engineering should have a place in every university engineering faculty. That was its proper home. Departments of chemical technology which had done good work in the past were out of date and were no substitute for chemical engineering with the generality of its training and its adaptability to varied tasks which the previous speakers had emphasised. He hoped that in the bold plans for engineering and chemistry on an adjoining site in the Queen's University of Belfast, chemical engineering would find a place. If, instead of exporting its fat cattle alive, Northern Ireland were to kill them at home, great processing industries would develop in which chemical engineers would be needed.

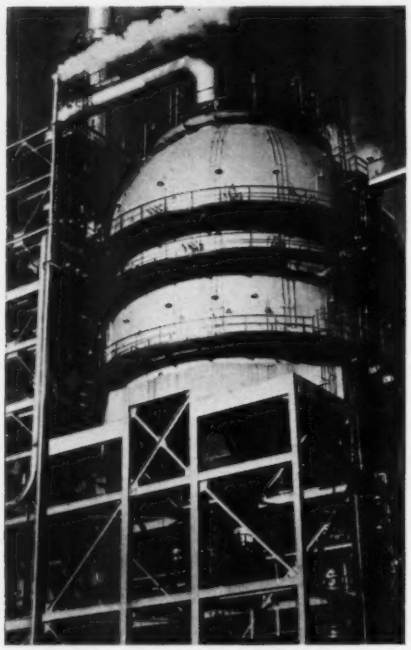
Sir Harold then spoke of the problem of meeting the growing needs of the world which the President had emphasised in his address, and of the vital part the chemical engineer must play in processing raw materials with the utmost efficiency. He quoted again the remark of Steinmetz to Carl Bosch: 'I know you can make indigo cheaper than God. Some day you may make rubber cheaper than God, but you will never make cellulose cheaper than God.' The implication of this was a closer partnership with Nature, to which biochemical engineering was the key. He took as an example the rapid production of antibiotics on an engineering scale made possible by scientific controls. That was an example of the part chemical engineering would play 'in the shape of things to come.'

Finally he appealed to engineers of the older technologies for support and recognition of the chemical engineer as a member of their team; he was complementary, not competitive with them, and his presence would add greatly to the industrial strength of Britain.

Gas making, treatment, and storage plant has formed the backbone of the business of Ashmore, Benson, Pease and Co. for more than 80 years. The modern range of gas plant made by this well-known company is briefly described and illustrated in a new booklet. The gasholders range from a Wiggins gasholder, with a frictionless movable piston, capacity 10,000 cu. ft., to a Klonne type blast furnace gasholder with a capacity of 3,000,000 cu. ft. In addition to gasholders the company make condensers and purifiers, which are briefly described.

Machining rarer metals. The widening use of the rarer metals—including tungsten, molybdenum, tantalum, titanium and zirconium—in industry has increased the need for knowledge of their optimum machining conditions. A booklet issued by Protolite Ltd. entitled 'The Machining of the Rarer Metals,' gives the findings of the company's tool testing department with tooling recommendations and methods for each metal.

New Plants at Fawley Refinery



The regenerator unit of the 265 ft. high fluid catalytic cracking plant, the first unit of its type to come into production in Britain. Operated by a crew of only nine, it is already producing high-quality petrol at the rate of 1 million gal./day.

IN September 1951 the Fawley refinery of the Esso Petroleum Co. Ltd. was put on stream. This £37,500,000 plant, which was described in our October 1951 issue, was built in 27 months, from July 1949 to September 1951, on a 450-acre site overlooking Southampton Water. During the first twelve months of operation production has been well up to expectations. Furthermore, the installation of ancillary units due to come into operation this year and next has been kept to schedule.

New plants

The polymerisation plant was completed last month and increases further the yield of high-quality petrol. The process absorbs some of the waste gases until recently burnt at the flare stack and thus considerably diminishes the size of the safety flare.

The next ancillary unit scheduled for completion is the tractor fuels plant. When ready next April, a new source of high-grade tractor fuel will be available for agricultural purposes.

Some 12,000 tons p.a. of pure rock sulphur will be produced by the sulphur recovery plant, due for completion in June 1953. The Middle East crude oil processed at Fawley has a particularly high sulphur content.

Finally, the completion of the lubricating oils plant, comprising four units, in September of next year will mark the end of the second phase of the construction programme.

Anti-pollution measures

A total of £445,300 has been invested in facilities to avoid air and water pollution at the refinery. Normal combustion products from refinery furnaces are released 250 ft. above the ground. Surplus gases are burnt at the safety flare stack. A deodoriser plant treats objectionable fumes.

To meet the more complicated problem of water pollution, other modern equipment has been installed. All cooling water must pass through an oil separating plant before discharge into Southampton Water. Ballast water discharged by tankers prior to loading is purified in a special tank.

The first of the four units of the lubricating oils plant due to be completed next autumn.

Materials

It was originally thought that at least 66% of the materials required for the new refinery would have to be bought in the U.S.A., owing to poor delivery prospects from British manufacturers, at a time when speed was essential. The position has now reversed and British manufacturers are supplying 67% of the equipment for the additional features.

Fluid catalytic cracker

The main unit at Fawley is the fluid catalytic cracking plant which was completed in September of last year. It has so far produced over 100 million gal. of high-quality motor spirit. The catalyst used at this plant, formerly manufactured in the U.S.A., is now made at a factory specially built at Warrington, Lancashire, by J. Crosfield & Sons Ltd., in co-operation with a number of other interested companies (see CHEMICAL & PROCESS ENGINEERING, 1952, **33**, (4), 192).

Output and distribution

During the first twelve months of operation, approximately 6 million tons of crude oil, all imported from the Middle East, were processed at Fawley to yield the following principal products:

	Tons	*Million gal.*
Motor spirit	1,750,000	(540)
Kerosine	300,000	(70)
Gas oils and fuel oils ..	3,500,000	(500)

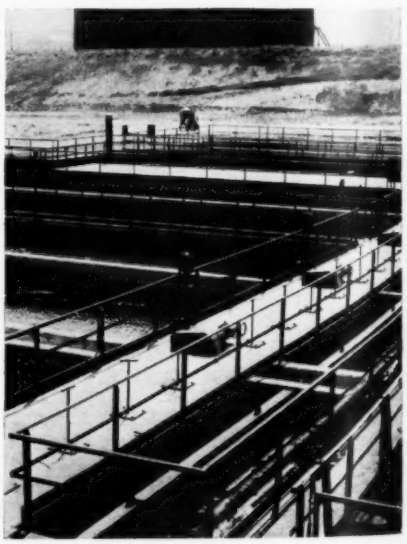
This represents approximately 30% of the U.K.'s total oil consumption for the period. Of these products, some 84% was distributed within Britain, including a considerable sale to other British oil companies. Approximately 1 million tons of finished products, 16% of the total output, were exported.

The estimated output for 1953 is well over 6.5 million tons. Much of the increase will be accounted for by additional products coming from the new installations.

Marine terminal

The 3,200-ft.-long jetty of the Marine Terminal is one of the longest oil docks in the world, having four breasting islands capable of berthing simultaneously four tankers of up to 40,000 tons at low tide.

During the period under review, 701 ocean-going tankers were handled at the jetty, of which 348 were importing crude oil. The average figure for all types of vessels handled at the jetty is 230 a month, whilst incoming and outgoing cargoes average 7 million gal./day. Of products



The oil and water separator tanks. Oil-polluted water from the refinery is passed through these tanks, where the oil is skimmed from the surface and returned to crude stock, while the pure water is discharged into Southampton Water.

leaving the refinery, over 97% go out from the Marine Terminal and 65% of the shipping involved is British.

A staff of 72, working in three shifts and specially trained in the handling of loading and unloading equipment, is under the supervision of the Marine Superintendent at the jetty.

Revenue

Three tugs are required to handle tankers of 26,000 tons and over, whilst two are needed for smaller vessels. Charges for tugs, together with harbour dues, pilotage and Trinity House light dues, cost of stores and other services, represent a revenue of some £900,000 p.a. for the Port of Southampton.

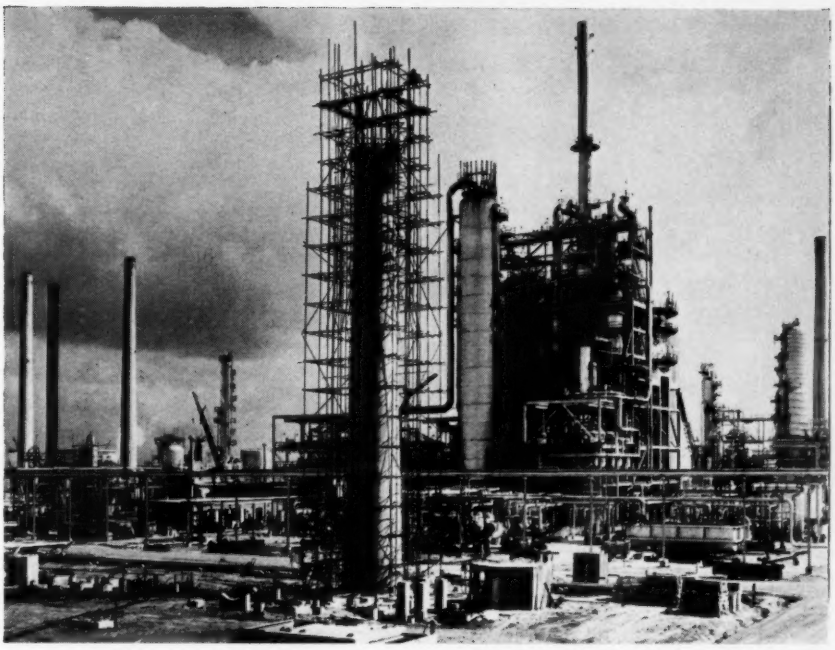
The value of finished products, as shipped from the refinery during the first year, is over £60 million. Taxation on the motor spirit and diesel oil produced at Fawley represents a yearly revenue to the Exchequer of £75 million.

After deducting the dollar component in the purchase price of the crude oil from the value of the refined products which would otherwise have had to be purchased for dollars, a saving of some $80 million is shown. With the increased output estimated for 1953, it is confidently expected that this figure will rise to over $100 million.

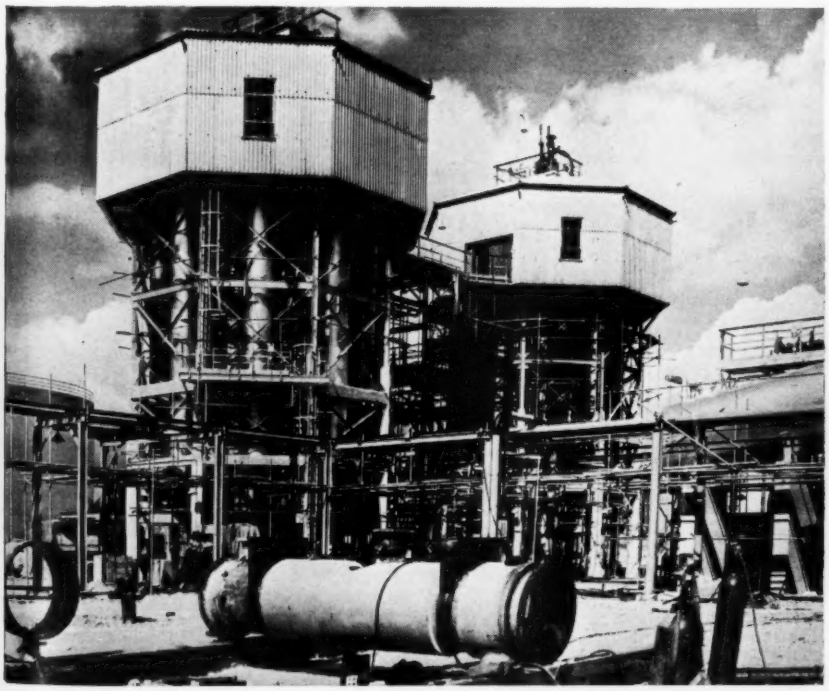
Workers

At the height of construction the labour force at Fawley reached 5,000 men, a figure which has now dropped to 1,130 working on the new installations. By the end of 1953 this force will have been dispersed.

The number of operative employees at the original refinery—900—has grown to 2,250, most of whom have been recruited locally. By the end of 1953 the figure will have risen to 2,500.



The sulphur recovery plant under construction. Due for completion early in 1953, its planned output is 12,000 tons p.a. of pure rock sulphur.



The polymerisation plant under construction. Now completed, this plant will further increase the yield of high-quality petrol. The process absorbs some of the waste gases until recently burnt at the flare stack and considerably diminishes the size of the safety flare.

Fertiliser Plant

(*Concluded from page 607*)

from local sources. Proven deposits at the Negev quarries now being worked contain 10 million tons of phosphate rock and estimated reserves amount to 100 million tons. An existing superphosphate plant has operated since 1951 using only local rock. Potash will be obtained from the Dead Sea. Waste gases will be used from the British-owned oil refineries near the fertiliser plant. Pyrites will be imported, there being adequate supplies in Greece and Cyprus.

The Israeli Ministry of Agriculture estimate local fertiliser requirements for this year at 100,000 tons single superphosphate, 35,000 tons ammonium sulphate and 10,000 tons nitrates. Requirements are expected to increase by 15% p.a. during the next five years.

This project forms part of the general industrialisation of Israel and the heavy chemicals produced at this new plant and not used for fertilisers will find a ready and increasing home market. For instance, Oscar Kohorn & Co., of New York, are investing $2 million in a rayon plant which will involve a total investment of $5 million and I£1 million (see CHEMICAL & PROCESS ENGINEERING, 1952, **33**, (4), 204). Indigenous mineral resources have been investigated (*Ibid.*, (5), 267). Among many other proposals the possibility of setting up a steel industry has been studied (*Ibid.*, (6), 329). The latter would use waste from the pyrites processed by the fertiliser company, as well as Negev iron ore and local scrap iron.

SAFETY

Legal Obligations of the Chemical Engineer—2

By C. B. Roos, B.Sc., F.R.I.C.

(Formerly H.M. Deputy Superintending Inspector of Factories)

In the first of these two articles, published in our October issue, the obligations of the chemical engineer under the various sections of the Factories Acts were discussed and certain measures to enable him to secure compliance were suggested. Besides the direct requirements of the Acts, however, the Minister of Labour has power, under Section 60, to make Special Regulations in respect of any manufacture, plant, process or description of manual labour which he is satisfied is of such a nature as to cause risk of bodily injury (including injury to health) to persons employed. Between 50 and 60 of such codes of Special Regulations are at present in force and they cover a wide variety of processes. Some of those are discussed in this article, in which the author also deals with industrial diseases, codes with which the chemical engineer may be concerned, the Industrial Injuries Act and Common Law liabilities.

SPECIAL Regulations may roughly be divided into three classes:

1. Those dealing entirely with risk of physical injury. Examples are the Celluloid Regulations, the Cinematograph Film Regulations and the Kiers Regulations.

2. Those dealing entirely with risk of injury to health. Examples are those made for chromium plating, indiarubber manufacture, lead compound manufacture, lead smelting, pottery and the manufacture of refractory materials.

3. Those covering both bodily injury and health risks. The regulations for chemical works and for the manufacture and use of cellulose solutions particularly concern the chemical engineer.

Risk of physical injury

One of the most important hazards with which the chemical engineer has to contend is that of fire. The Celluloid Regulations, 1921, apply to the manufacture, manipulation or storage of celluloid or any article wholly or partly made of celluloid and require that stocks of celluloid shall be kept in a proper celluloid store outside the workroom, which, if the stock exceeds 1 cwt., must be constructed of fire-resisting material. Celluloid waste created in the process must be kept in suitable receptacles and removed daily from the workroom. Efficient steps must be taken to prevent celluloid from coming into contact with open lights or fires and smoking is, of course, forbidden. A stock of fire extinguishers must be kept available, and adequate means of escape in case of fire, with notices specifying such means, must be provided.

The Manufacture of Cinematograph Film Regulations, 1928, impose even more stringent requirements, and apply to the manufacture, repair, use or storage of any film containing nitrocellulose or other nitrated product. The rooms in which the film is manufactured, etc., must be fire-resisting, and there are special provisions relating to store-rooms which include the fitting of a gas-relief space, the area of which must be not less than 70 sq. in. and not more than 90 sq. in. for every 500 lb. of film stored in the room. Special requirements for electrical apparatus used in store-rooms are also laid down. The Cinematograph Film Stripping Regulations, 1939, contain similar provisions.

The Kiers Regulations, 1938, deal with the dangers of boiling liquid being accidentally introduced into kiers, *i.e.* fixed vessels used for boiling textile material in print works, bleaching works and dyeing works. Many fatal accidents have occurred through accidental entry of steam or boiling water while workers were engaged inside these vessels and, although the regulations apply only to the processes and industries referred to above, they serve as a model for other industries where this danger exists and will repay careful study in spite of their limited application. There are special requirements as to isolation and disconnection of pipes, and it is also laid down that an authorised person must be appointed to supervise the arrangements for such isolation and disconnection. Entry into kiers is prohibited until a notice has been affixed by such authorised person permitting the kier to be entered.

A comparatively recent code which deserves mention is the Magnesium (Grinding of Castings and other Articles) Regulations, 1946, which prescribe certain special requirements to minimise the danger of the serious fires and explosions which can occur from the ignition of finely powdered magnesium. Precautions against causing sparks include restrictions on the method of 'racing' (*i.e.* trueing-up) grindstones used in the processes. Exhaust arrangements are required for dust removal and these must include a scrubber in which the dust-laden air is effectively drenched with water when such air has travelled a horizontal distance of not more than 10 ft. Automatic arrangements must be installed to ensure that the fan and scrubber are in effective operation before the grinding or polishing wheel can be started up, and the actual polishing or grinding must not be started until the fan and scrubber have been running for the preceding 5 min. Sludge must be removed from the scrubber once a week and there are stringent provisions as to its disposal. Smoking, open lights and fires are not permitted within 20 ft. of either grinders or scrubbers.

Risk of injury to health

Many of the 'industrial diseases,' *i.e.* bodily diseases or illnesses directly attributable to a worker's employment, such as lead, mercury and phosphorus poisoning, anthrax and silicosis, have been known for many years and precautions have been prescribed by regulations. With the growth of industry, however, new chemicals with dangerous toxic effects are constantly being manufactured or used, and the chemical engineer must always be on the alert, as otherwise a heavy crop of cases of industrial poisoning may result from the introduction of a compound with little-known toxic hazards. If a new chemical is to be produced or used it is a wise precaution to consult the District Inspector of Factories, who will usually be able to obtain the necessary information from his department.

As might be expected, there are many codes of regulations aimed at the prevention of lead poisoning and it is encouraging to note that this disease, which in past years exacted a heavy toll in industry, is becoming less prevalent as a result of legislation. Lead poisoning usually occurs in industry as a 'chronic' poison, *i.e.* it is acquired by the absorption of small doses over a long period. The Lead Compounds Regulations, 1921, apply to the manufacture of carbonates (*e.g.* white lead), sulphate, nit-

rate and acetate of lead, all of which compounds are extensively used in industry and have been responsible in the past for many cases of lead poisoning. The regulations require damping of white lead when made by the 'stack' or 'chamber' process, and the corrosions must be maintained in a damp condition during further operations. Dry lead compounds must be kept in receptacles which are either covered or fitted with means (*e.g.* exhaust ventilation) which prevent escape of dust, and an exhaust draught is also required to prevent such escape from any furnace used in a lead process. Periodic medical examination and the provision of overalls, respirators, messroom, cloakroom and washing accommodation are also required and the regulations also place a duty on the worker to use the facilities provided. The Lead Smelting Regulations require similar precautions in the process of smelting lead from ore.

There have been various codes of regulations dealing *inter alia* with the dangers of lead poisoning in the pottery industry where for many years the glazes used contained a substantial proportion of lead. The latest Code (Pottery (Health) Special Regulations, 1947) has taken the bull by the horns and prohibited the use of any glaze other than 'leadless,' *i.e.* containing less than 1% of lead, or 'low solubility,' *i.e.* containing less than 5% of lead soluble in dilute hydrochloric acid.

The Chromium Plating Regulations, 1931, were made to guard against the dangerous properties of chromic acid which forms ulcers when left in contact with the skin. In addition, when given off in the form of an atomised spray from the plating bath, it attacks, and can completely destroy, the nasal septum of any worker whose head may be over the bath during the plating process. Special exhaust arrangements are prescribed and other stringent requirements include fortnightly medical examination, protective clothing and examination of hands and forearms twice weekly by a responsible person to ensure that the worker is free from chrome ulcers.

The manufacture of indiarubber involves exposure to such dangerous chemicals as carbon bisulphide, sulphur chloride, benzene, carbon tetrachloride, trichlorethylene and lead compounds and the Indiarubber Regulations, 1922, require efficient exhaust draught or exceptionally good general ventilation ensuring not less than 30 changes of air per hour in any room in which the above compounds are used. They also require complete enclosure of a vulcanising machine used in the cold-cure process and stipulate that no person shall be employed in a room in which carbon bisulphide is used for more than 5 hr. in all in any one day, nor for more than 2½ hr. without a rest interval of at least 1 hr. Periodic medical examination, the provision of overalls and a messroom are other requirements.

The Grinding of Metals (Miscellaneous Industries) Regulations, 1925, the Grinding of Cutlery and Edge Tools Regulations, 1925, and the Refractory Materials Regulations, 1931, are all designed to minimise the dangers of silicosis. The first two codes are almost identical and regulation 1 in each code requires suitable arrangements to be provided for removal of dust in the process of dry grinding. If natural sandstone, which is practically pure silica, is used, further measures are necessary, including inlet and exhaust general ventilation, a minimum height standard for workrooms and minimum area of window space, and the general effect of the regulations has been for employers to replace the dangerous sandstone wheels by wheels of abrasive material which is non-siliceous.

The manufacture of refractory materials such as steel furnace linings, crucibles and silica bricks has also caused much silicosis among the workers, and the Refractory Materials Regulations, 1931, require exhaust or water spray at crushers, and total enclosure for chutes, conveyors, elevators, screens, etc. Other requirements are daily damping and cleaning of floors and damping of refractory material when loading or unloading at wagons. The regulations only apply when the material manufactured contains not less than 80% total silica (SiO_2) and do not apply to the handling, moving, mixing or sieving of natural sands.

Radioactive materials

The particular dangers of radiation from radioactive material are dealt with in the Factories (Luminising) Special Regulations, 1947, which apply to all factories where luminising, defined as 'the application of luminous compound to any surface or the introduction of luminous compound into glass tubing,' is carried on; luminous compound is defined as 'luminous material containing a radioactive substance.' The regulations require 14 days' notice to be given to the District Inspector of Factories before commencing the process, and there are restrictions on the weekly hours of work and length of continuous employment. Exhaust draught must be provided at every workplace where luminising compound is manipulated or articles are examined after luminising, ventilated cabinets and glass screens must be provided for manipulation of dry powder of luminous compound and the means of ventilation must be regularly cleaned. There are special precautions laid down as to drying stoves and the construction and cleaning (by a moist method) of floors, benches and tables. Brushes must not be used for applying luminous compound. There are other requirements as to storage and use of containers for luminous compound, washing facilities (including 'washing time'), provision of protective clothing and paper handkerchiefs, prohibition of meals, smoking and the use of cosmetics in workrooms, and periodic medical examination. In addition, each worker must be tested for exposure to radiation every three months.

Although the Luminising Regulations do not apply specifically to the handling of radioactive materials for purposes other than luminising, persons intending to use such materials for any purpose would be well advised to ascertain their liabilities under Common Law.

Bodily injury and health risks

The most important regulations in this category, from the point of view of the chemical engineer, are the Chemical Works Regulations, 1922. The regulations are divided into two parts, Part I applying to all the processes included in the schedule to the regulations. This is too long to quote here, but its net is so wide that most of the chemical works in the country are subject to the code. The application of Part II is limited to works where caustic pots are used, chlorate or bleaching powder is manufactured, gas tar or coal tar is distilled or used, factories where nitro, amido or chrome processes are carried on, crude shale oil is refined or nitric acid is used in the manufacture of nitro compounds. The regulations were made many years before the passing of the 1937 Act and many of the provisions are included in the Act itself. Among others which are not so included is Regulation 1 (b), which requires gangways over vessels containing dangerous liquids to be at least 18 in. wide and to be securely fenced to a height of 3 ft. Part I of the regulations also includes requirements for exhaust ventilation for any process involving the action of acid or alkali on metal where arseniuretted hydrogen is likely to be given off. The particularly deadly character of this gas is also emphasised by the requirement in Regulation 9 that non-metallic spades, scrapers and pails must be provided for the use of persons engaged in cleaning out any vessel which has contained hydrochloric or sulphuric acid or other substance which may cause evolution of arseniuretted hydrogen. The regulations also include precautions against explosion and fires due to electric arc lamps or stoves; the provision of breathing apparatus, oxygen and lifebelts in places where dangerous gas or fume is likely to be evolved and a requirement that breathing apparatus must always be worn for purposes of rescue. Breathing apparatus is defined in these regulations as (1) a helmet or facepiece with necessary connections by means of which a person using it in a poisonous asphyxiating or irritant atmosphere breathes pure air and (2) any other suitable apparatus approved in writing by the Chief Inspector of Factories.

Included in Part II are certain requirements as to the construction of caustic pots, and the isolation of tar stills and the ventilation and testing of bleaching chambers before entry by any person. Special precautions are laid down to prevent workers breathing the highly toxic dust and fumes given off in nitro and amido processes, which are defined as 'the manufacture of nitro or amido derivatives of

phenol and of benzene or its homologues, and the making of explosives with the use of any of these substances.' Machines used for grinding or crushing caustic must be enclosed and also provided with exhaust draught, and such draught is also required for grinding, sieving, evaporating or packing in a chrome process (defined as the manufacture of chromate or bichromate of sodium or potassium) and for crushing, grinding, mixing of material or cartridge filling in a nitro or amido process. The regulations also require crystallisation, grinding and packing of chlorate or perchlorate to be done in a separate room not used for any other purpose and for the floor of the room to be of smooth impervious and incombustible material, which must be cleaned daily. There are other requirements which are perhaps more the concern of the personnel manager than the chemical engineer as to protective clothing, cloakroom washing and bath accommodation, messroom and periodic medical examination for certain workers.

The Cellulose Solutions Regulations, 1934, apply to the manufacture and use of solutions in inflammable liquids (defined as those with a flash-point below 90°F.) of cellulose acetate, cellulose nitrate, celluloid or other substance containing these compounds. The dangers of these solutions are mainly those of fire and explosion, although some solvents, notably those containing benzene, have toxic properties. The regulations require the employer to give notice to the District Inspector of Factories at least 14 days before commencing to manufacture or use the solutions and it is also advisable to notify the local authority in case a storage licence is necessary. Cabinets and rooms in which solutions are used (referred to in the regulations as ' cellulose spaces ') must be of fire-resisting material, and such material is carefully defined in the preamble to the regulations. The same requirement applies to ducts, trunks and casings used for the exhaust ventilation required for removal of fumes. Fires, flames and open lights are prohibited within 20 ft. of any cellulose cabinet, cellulose space or storeroom and heating and electrical apparatus liable to attain a temperature of 80°F. must be so situated or protected to prevent the deposition thereon of any solid residues of the solutions. Such solid residues must be regularly removed from all cabinets, ducts, trunks, etc., the reason being that, if allowed to accumulate, they have been known to ignite spontaneously through decomposition and consequent evolution of heat. Stocks of solutions must be kept in storerooms which must be either of fire-resisting material or in safe positions at least 30 ft. from any occupied building. It is also important to remember when dealing with cellulose solutions that, by Regulation 27 of the Electricity Regulations, all electrical apparatus used in close proximity to these solutions should be of ' flame-proof ' or ' totally enclosed ' type.

Industrial poisoning and disease

It is proposed to deal briefly with the various types of industrial poisoning and disease, some of which have already been mentioned. Poisons can enter the body (1) by inhalation through the lungs; (2) swallowing *via* the stomach; and (3) through the skin. The method of entry is usually decided by the physical state of the poison, *i.e.* whether it is solid or liquid, or in the form of dust, gas or vapour. Poisoning may be ' acute,' *i.e.* caused by one strong dose, or ' chronic,' *i.e.* caused by small doses over a prolonged period, the latter being the one most usually found in industry. The metallic poisons include lead, mercury, arsenic, phosphorus, manganese and chromium. Lead and arsenic have already been mentioned, arseniuretted hydrogen being a striking example of an acute poison, as a comparatively small dose can have fatal effects.

Mercury is not poisonous in the liquid form, but the vapour, which is given off at normal temperature and pressure, is a well-known chronic poison. Particularly dangerous poisons used widely in industry are the alkaline cyanides, and stringent precautions must be taken to avoid mixing such cyanides with acid, for obvious reasons. The writer has actually seen open baths containing cyanide solutions side by side with baths of acid, with no indication of contents. It is advisable for the official cyanide Cautionary Placard (Form 385) to be affixed and for the cyanide antidote mentioned thereon to be immediately available. Silicosis and asbestosis are examples of chronic diseases which may take years to develop.

Various liquid solvents have poisonous effects usually due to vapour or fume, and examples are benzene, toluene, carbon tetrachloride, trichlorethylene, carbon bisulphide and methanol (methyl alcohol). All these cause poisoning by inhalation, but the poisonous effects of nicotine (which is particularly deadly as a few drops can cause death) and aniline are due to their passage through the skin.

Industrial dermatitis, which is not strictly ' industrial poisoning ' but which is the basis of many Common Law claims, can be caused by practically any substance, solid or liquid, if the exposed worker is susceptible to that particular substance, but certain compounds, such as mineral oil, chromium salts, flour, sugar and turpentine, are well known as causes of dermatitis and special precautions are recommended if these are handled.

Of the poisonous gases, carbon monoxide probably causes most casualties in industry owing to its colourless and odourless character and to the low concentration necessary for a fatal dose. Other common gases which require special precautions are ammonia, chlorine, nitrous fumes and sulphuretted hydrogen, the last two being particularly dangerous owing to their ' delayed ' effect.

The dangerous effects of radiation have assumed particular importance of recent years, particularly the rays from radioactive materials and *x*-rays. In addition, certain light and heat rays such as those from steel furnaces and electric welding burners have harmful effects, especially on the eyes of workers. In the case of electric welding, not only should the welders and their assistants be provided with proper goggles and screens but the welding area should be effectively screened from the rest of the shop—a point frequently overlooked—to avoid the painful eye affection known as ' arc-eye ' among the other workers.

As to prevention, apart from such obvious precautions as total enclosure, exhaust ventilation with use of a fume cupboard, and improved general ventilation, the danger of poisoning can often be entirely eliminated by substituting a ' safe,' *i.e.* non-poisonous, substance for a dangerous one. The substitution of non-siliceous abrasive material (usually alumina) for natural sandstone in the grinding industry and the use of leadless or low-solubility glazes in the pottery industry has already been mentioned. Other examples are the use of shot instead of sand in the blasting of castings, and of non-siliceous parting powders in foundries, both these changes having taken place as a result of recent legislation (Blasting of Castings Regulations and Parting Powder Regulations). In the case of liquid solvents, an example of a ' safe ' solvent is white spirit and it might be possible in some processes to use it in place of a poisonous solvent, as it has the additional advantage, from the ' safety ' point of view, of having a comparatively high flash-point.

The physical protection of workers is sometimes the only possible means of prevention, but it should always be regarded as the last resort. Respirators are usually uncomfortable, but must sometimes be worn; the use of goggles is the only known protection against welding rays; and gloves and aprons are usually necessary in the case of poisons which act by passage through the skin and for the prevention of dermatitis. A further precaution is periodical medical examination, which is required by statute under certain codes of regulations. Many enlightened employers have now arranged voluntarily for such examination, with beneficial results.

The law of employers' liability

The law as to employers' liability has been greatly modified by recent Acts of Parliament, as follows:

1. Until 1945 a workman found guilty of contributory negligence could recover no damages, but under the Law Reform (Contributory Negligence) Act, 1945, the only effect of a plea by the employer of contributory negligence on the part of the worker is to reduce the amount of damages in proportion to the degree of contributory negligence.

2. Until 1946 if an injured worker

accepted compensation (under the Workman's Compensation Act) from his employer he could not take proceedings at Common Law for damages. Under the National Insurance (Industrial Injuries) Act, 1946, increased rates of benefit, to which the employer and worker contribute equally, become payable automatically by the State, and the worker is free to take proceedings at Common Law against his employer if he wishes to do so.

3. The Law Reform (Personal Injuries) Act, 1948, abolished the 'doctrine of common employment' and an employer is now liable for the negligence or other 'torts' (*i.e.* any form of wrong-doing or wrong action) of his employees, if these torts result in injury to a fellow-worker.

Generally speaking, an employer is liable to pay damages to his employees for personal injury (including injury to health) which they may have sustained in the course of their employment. Such liability may arise (1) from a breach of a statutory requirement by an employer; (2) from a fault on the part of a fellow-employee of the injured person for whose acts the employer is liable; or (3) from negligence on the part of the employer. So far as breach of statute is concerned, there is no need to prove negligence, as the liability in this case is absolute—so absolute that it renders the employer liable in some cases for defects in machinery or plant which he has no power to prevent. One example of this may be quoted. Section 22 (1) of the Factories Act, 1937, requires that a hoist of lift 'shall be of sound construction and adequate strength.' In a recent case an accident occurred through a lift not being of sound construction when supplied to the employer, and the House of Lords ruled that the above requirement was absolute, and that the employer (*i.e.* the user of the lift) was liable, although the lift may not have been of sound construction or adequate strength when supplied to him by the manufacturers.

Where negligence is alleged in a common law action it is not necessary to prove that the employer is personally guilty of negligence. Negligence by the employer includes cases where (1) general safety measures have been neglected; (2) there has been negligence, or a wilfully dangerous act, on the part of a fellow-worker; (3) there has been a 'bad system of work'; or (4) unsafe plant was in use. So far as general safety measures are concerned, typical defects which have been successfully pleaded are unsafe roofs and walls, slippery floors and permanently bad ventilation. Where explosive or inflammable gases are liable to be present it has been held that failure to provide a staff, or an official, competent to test for such gases was 'neglect' and presumably the same argument would apply in the case of a toxic gas. There is, in fact, a general duty at Common Law to provide adequate and competent supervision and this particularly applies where accidents have been caused by removal of guards or interference with other safety or health appliances. It is obvious that such supervision is particularly important in view of the employer's comparatively new liability in respect of the 'torts' of his employees.

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Safety boots and shoes

About 4% of successful claims for injury benefit from industrial accidents in 1949 and 1950 were related to foot injuries, according to Ministry of National Insurance figures. Since the total number of accidents in 1950 was roughly 730,000, the number of foot injuries was about 29,000. Of these, about 13,000 would come within the category of factory accidents as distinct from mining, railway and non-factory accidents. Some years ago the Chief Inspector of Factories estimated that two-thirds of these mishaps would not cause appreciable injury if the workers' feet were protected by specially built boots with internal toecaps.

Up to 11 years ago there were no recognised standards for the manufacture of safety boots and many types sold as protective failed in service. In 1941 the British Standards Institution issued B.S. 953, 'Strength tests for the protective toecaps of footwear used for industrial purposes.' During the war and for some time afterwards, there was, however, a shortage of steel sheet of sufficient strength to meet these test conditions. These difficulties have now been overcome. The strength tests have now been revised and a new specification drawn up.

The new standard, 'Men's safety boots and shoes,' B.S. 1870: 1952, lays down minimum standards of make and construction for safety boots and shoes intended to provide both safety against blow and satisfactory wear in use. Tests for compliance with this standard have to be made by a recognised testing authority.

The safety device is a toecap of specially tempered steel, fitted either internally or externally in the course of manufacture. It weighs less than 2 oz. and is designed to withstand a shock test of 150 ft.-lb. or a dead weight of 3 tons. The cap can be incorporated in both boots and shoes, as well as in shoes for women. In the case of miners' boots, the toe cap is on the outside so that the leather will not be worn away.

The use of the registered certification mark of the B.S.I., which has been used for many years on protective toecaps, is included in the marking requirements for each type of safety boots and shoes. This mark on a product is an independent guarantee that the product does in fact comply with the requirements of the standard. It may be applied to safety boots and shoes only by manufacturers who obtain a licence from the B.S.I.

This standard was prepared under the supervision of the Personal Safety Equipment Standards Committee, which consists of representatives of 30 different industrial organisations including the Association of British Chemical Manufacturers, British Chemical Plant Manufacturers Association, British Iron and Steel Federation, Glass Manufacturers Federation, Imperial Chemical Industries Ltd., Royal Society for the Prevention of Accidents, Trades Union Congress and a number of Government departments.

Thermometers. In their latest catalogue H. J. Elliott Ltd. list a wide range of thermometers for both industrial and domestic use. Their thermometers for the laboratory and for chemical manufacture include common thermometers covering the freezing and boiling points of water, others for temperatures above the boiling point of water, high range thermometers made of boro-silicate tubing, and low-range mercury and spirit filled types. A variety of thermometers is listed for use in testing petroleum and allied products, and made to Institute of Petroleum specifications, the thermometers being graduated for various petroleum processes.

Progress of Chemical Industry's Expansion Schemes

A.B.C.M. CHAIRMAN'S SPEECH AND ANNUAL REPORT

THE chemical industry's plans for expanding production capacity during 1949-1953, as outlined in the report on the industry drawn up by the Association of British Chemical Manufacturers, called for an expenditure of £200 million. A progress report on these schemes was given by Mr. C. G. Hayman, chairman of the A.B.C.M., to the annual general meeting held in London on October 9. According to him, 41% of the schemes have been completed, 34% are still in progress, of which many should be finished this year, 15% have been postponed, mainly owing to building licence difficulties, and 9% have been abandoned. The actual expenditure has generally exceeded estimates. Of the £8.3 million-worth of research and development schemes projected in 1949, 50% by value have been completed, 36% are in progress, 8% have been postponed and 6% abandoned.

Output. Discussing the index of chemical output in the light of the expansion programme, Mr. Hayman said that based on 1946 taken as 100, the official Board of Trade index was 123 in 1949 and 165 for the first half of 1952, an advance of 7 points over 1951. However, he warned that these figures rather masked the general trend of chemical production which was downward. This led him to refer to the trade recession and the restrictions imposed by various countries to restore their trade balances. The chemical industry, particularly dyestuffs had suffered. However, he detected slight signs of improvement in the U.K. In any event he urged that the present depression should not deter the industry from going ahead with its expansion schemes.

Exports. In spite of the difficulties mentioned and the buyers' market which had replaced the easy selling conditions of the post-war years, British chemical exports were up ; they amounted to £142.5 million in 1951 compared with £107.5 million in the previous year, and in the first six months of 1952 there was another rise, the value being close on £76 million. However, dollar market exports were down.

Raw materials. The trade recession had resulted in a surplus of many raw materials and a new set of problems. The chemical industry should not forget that it was its own best customer and had in its own hands the opportunity for close co-operation which would minimise the effect of violent changes in supply and demand.

Effluents. Recent legislation meant that the industry had 7 years to make arrangements for the treatment of effluents to make them innocuous for discharge to waterways without damage to animal and plant life. Mr. Hayman called for pooling of information and experience and co-operative sponsorship of investigations in order to solve the effluent problem efficiently and economically.

ANNUAL REPORT

The attitude of the Association to the Cremer report on chemical engineering research is described in an Editorial note in this issue. Other points in the annual report are :

Dyestuffs. The industry is carrying out research to find new products especially since the Swiss and Germans have introduced new types for which at present there are no British equivalents.

Heavy chemicals. The report on the productivity team that toured America earlier this year should be published soon and a joint committee with the Association of Chemical and Allied Employers will be set up to implement recommendations. The U.S. chemical industry has been invited to send a team here on a similar basis.

Raw materials. The Shortages Committee regards as temporary the present surplus of many formerly scarce materials and is watching supplies very carefully, especially of coal carbonisation products.

German chemicals. Competition from Germany increased considerably during the year and 1951 exports, calculated on a similar basis to U.K. figures, were £121.3 million, an increase of £30 million on 1950. Soon all Allied restrictions on the industry would be removed.

U.S. market. The possibility of the U.S. Government invoking the escape clause of the G.A.T.T. to suspend tariff concessions with regard to chemical imports is a serious matter and H.M. Government have been approached by the Association.

Toxic chemicals. The Medical Research Council has agreed to answer questions from members for an experimental period of two years. Tests for acute toxicity will be undertaken if needed.

Officers. New *president* of the Association is Sir Harry Jephcott. Mr. C. G. Hayman continues as *chairman*. Mr. W. J. Worboys is new *vice-chairman*. Mr. C. E. Carey continues as *hon. treasurer*.

Steam heating

This monograph* describes the results of investigations on the heating effect of flowing superheated and saturated steam. The experiments were carried out by the author at the suggestion and under the direction of Prof. E. Kirschbaum in his Institute for the Design and Construction of Chemical Apparatus and Equipment at the Technical University in Karlsruhe. The work is notable for its clear composition and for its descriptions of numerous tests, the importance of which merits serious consideration.

The results of the investigations may be briefly summarised as follows.

At equal pressures in the steam spaces and identical types of condensation, the heating effect of superheated steam, at the velocities and temperature drops usually encountered in practice, is superior to the heating effect of saturated steam. Deviations of experimental results from calculated values lead to a number of conclusions regarding the flow of heat within the water layer on the cooling surface. The work also contains a number of interesting observations made under varying operating conditions.

**The Heating Effect of Flowing Superheated and Saturated Steam*, by Dr. Georg Winckelsesser. Dechema, Frankfurt/M. Pp. 12 + 27 illus. Paper covers. Price for members of the Dechema, D.M. 9.50; for non-members, D.M. 11.90 net.

The Leonard Hill Technical Group

Articles published in some of our associate journals in the Leonard Hill Technical Group this month include:

Manufacturing Chemist—Cold Sterilisation; Lanolin Manufacture; Progress Reports on Chemotherapy, Perfumery and Essential Oils, and Economic Poisons.

Food Manufacture—The Chemistry and Physics of Macaroni Products, Part IV: The Principles of Freeze Drying; Tieleman's Canning Factory, Leyden, Holland.

Petroleum—Stainless Steel in the Petroleum Industry; Stainless Steel and Aluminium in the U.S.A.

Muck Shifter—Construction Work for the Water Supply to the New Town of Crawley.

Atomics—The Equipping of Radiochemical Laboratories; Instrumentation for an Agricultural Radioisotope Laboratory; Radioisotope Laboratories for Animal and Agricultural Research.

World Crops—The Culture of the Tea Bush; The Columbia Basin Irrigation Project; Rumania's Crops; The Future of Phosphates; The Toxaphene Story.

Building Digest—Production and Use of Rubber Flooring.

Textile Industries — Society of Dyers' and Colourists' Summer School; Fibre Characteristics and Products of Ramie; Coir Fibre.

Plant and Equipment

Seal for centrifugal pumps

The *Morganite* positive-drive unit seal is designed for use in small low-pressure centrifugal pumps and other rotary equipment handling oil, water and other fluids at temperatures up to 100°C. Of simple robust design, it consists of a carbon sealing ring on to which is bonded a flexible rubber casing. Inside the casing is a stainless-steel spring, ensuring adequate sealing pressure. This assembly is an easy-push fit into a pressed-brass driving cup, having indentations into which the driving lugs on the carbon ring engage when the seal is compressed to its working length. The brass driving cup is in turn a press fit into customers' housing. This positive-drive feature ensures that no torque is transmitted through the rubber casing of the seal. Once the seal has been fitted, renewal of the sealing ring with rubber and spring can be done easily. The worn ring is pulled out of the brass cup and a new ring/rubber/spring assembly inserted by finger pressure. It is not necessary to remove the brass cup to renew the carbon ring. This sealing ring is claimed to provide a self-lubricating leak-tight running seal with a very low rate of wear.

It is suitable for a wide range of fluids such as oil, paraffin, hot water, liquid foodstuffs and beverages and any other liquid within the heat and chemical resistance of synthetic rubber. The working temperature should not exceed 100°C. It is effective against pressure in either direction, and the maximum recommended differential pressure of 5 p.s.i. (0.35 kg./sq.cm.) or vacuum of 10 in. (250 mm.) Hg allows a substantial margin of safety.

Either the unit can rotate with the shaft, the carbon ring sealing against a stationary counterface, or it can remain stationary in the equipment housing, with the counterface rotating. The carbon ring is clear of the shaft so that movement between them cannot occasion shaft wear associated with soft packings. The rubber casing forms a leak-tight wall between the carbon ring and the encircling brass driving cup which, in turn, is a light interference fit in the housing bore. As the casing is flexible, it allows the carbon ring sufficient axial movement to maintain effective sealing under normal working conditions.

Any good-quality cast iron (minimum Brinell 220) can be used for the counterface, but if the seal is likely to stand idle in water for long periods it should be of a hard non-rusting metal. *Ni-resist* cast iron, stainless steel (minimum Brinell 420) and hard phosphor bronze are particularly suitable (B.S. 369, Brinell 130). It should always overlap the carbon ring, *i.e.* larger on o.d., smaller on i.d. The unit is supported in an annular recess in the customers' housing, which should be machined to the recommended tolerance of B.S.I. "U" limits.

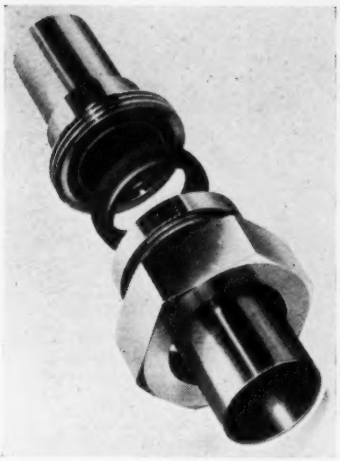
The *Morganite* positive-drive unit seal is supplied by the Morgan Crucible Co., Ltd.

Continuous pH recorder/controller

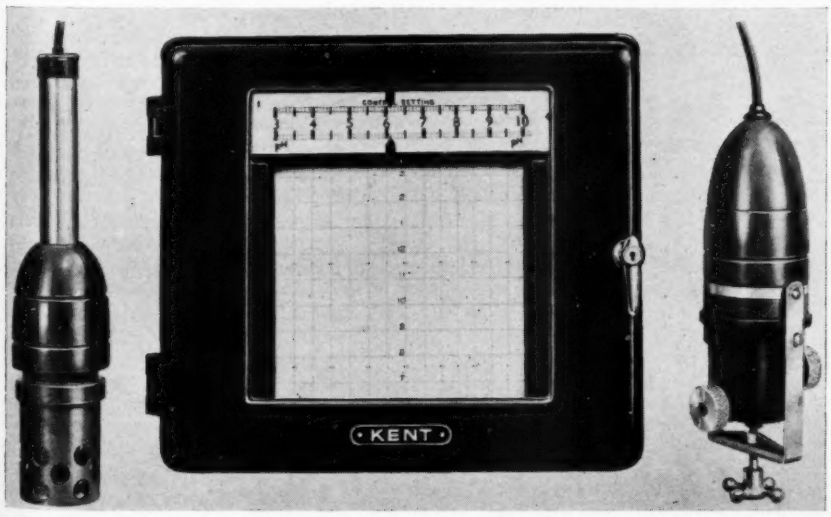
A new universal glass-electrode *p*H recorder facilitates automatic control of many industrial processes. It is claimed to have three advantageous features. Firstly, the instrument will provide accurate and continuous records of *p*H values over periods of several months without any maintenance, the addition of potassium chloride solution to the salt bridge being unnecessary. Secondly, it can be used to measure *p*H values under pressure, which has hitherto been impossible with the normal type of salt bridge. With the latter, a sample has to be bled at atmospheric pressure, increasing the tendency to blockage of the sampling supply, particularly when suspended matter is present; also the metered sample has to be run to waste or pumped back into the supply system. The accuracy of the new instrument is not affected by sampling under pressures of up to 75 p.s.i. Thirdly, the plug-in electrodes with quick-acting glands are of particular value where the sampling conditions are such as to cause rapid fouling of the electrodes, since cleaning is simplified.

The primary element, the body of which is made of high-temperature grade material, can be used in two ways. The tank-type can be arranged so that the electrodes just dip into the liquid or are completely submerged. This type has a built-in support complete with a quick-acting clamp. The tank-type can be converted into the flow-type, in which the liquid to be measured flows through a sealed hopper fitted to the electrode holder, by the adjustment of accessories. This type may be used for measurement under pressure.

Both models are robustly constructed and all parts in contact with the sample are made from non-metallic materials resistant to most corrosive agents. The combined reference/salt bridge electrode is unbreakable and pressure-compensated. The liquid



Exploded view of the new C.-B.T.S. sanitary pipeline fitting for forming a joint between permanent stainless-steel pipelines which is claimed to be strong enough to withstand high pressure, entirely free from crevices and perfectly hygienic. The fitting is easily dismantled and assembled without the use of tools. The joint is formed by a specially shaped and accurately dimensioned rubber gasket which fits into male and female liners fixed to the pipe sections. These are then held together by a nut. It is suitable for use in the milk and other food processing industries and is being manufactured by Clarke-Built Ltd., in collaboration with Talbot Steel Ltd.



Continuous *p*H recorder/controller. *(From left to right)* **Tank-type assembly, recorder/controller, flow-channel assembly.**

junction is resistant to fouling and is a separate component which can be replaced quickly at negligible cost. Three types of glass electrode are available which virtually cover the complete *p*H range.

Electrode	*pH range*	*Temperature range*	*Estimated continuous-operation life before servicing*
General purpose	0—10	<50°C.	>6 mths.
High-temperature	0—14	50—100°C.	About 2,000 hr. at 100°C.
High *p*H	10—14	<75°C.	>2,000 hr.

A nickel resistance thermometer, protected by a moulded rubber sheath, provides automatic temperature-compensation for the electrodes.

The measuring system comprises an electrometer and a recorder. The a.c., mains-operated, impulse-type electrometer measures the potential of the electrode system. The electrometer circuit has a high input impedance which is symmetrical with respect to earth. Only one valve is used in the electrometer circuit and this is a standard radio type. Variations in the valve characteristics do not cause zero drift, and changes in mains supply voltage do not affect accuracy. The electrometer is housed in a strong sealed case which can be mounted up to 100 ft. away from the primary element. The self-balancing potentiometer/recorder may be located up to 500 ft. from the electrometer.

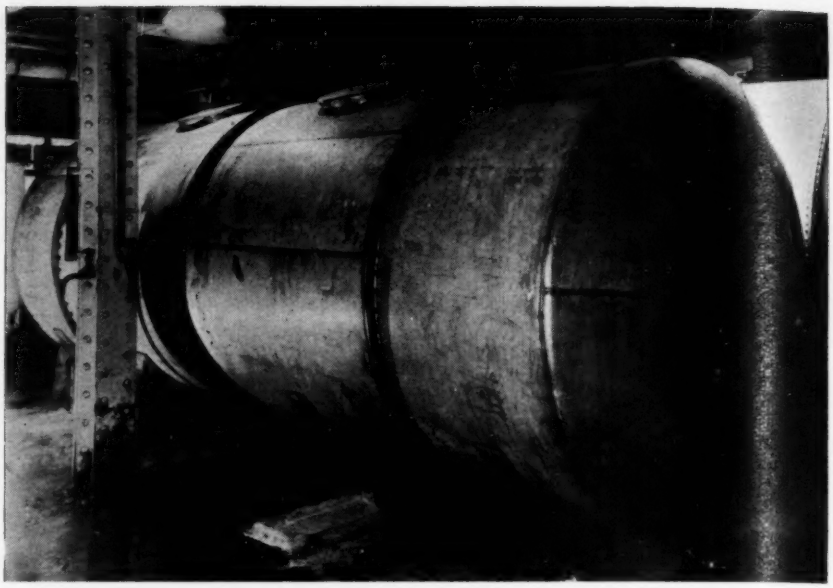
Processes involving the circulation of hot liquor can, for example, be automatically controlled pneumatically with the aid of this new universal recorder. Until now the time-lag involved in cooling a sample has ruled out automatic control with conventional *p*H meters. The instrument is made by George Kent Ltd.

Rubber heating sheet

Rubber sheeting for applying heat to chemical plant is being marketed by Electrothermal Engineering Ltd. It is a flat sheet of black rubber wired to produce 150, 250 or 400 watts/sq.ft. and it is mains operated. It will radiate heat at controlled temperatures up to 200°C. sufficient for all applications of heat to flat, shaped or curved surfaces where the heat input does not exceed 400 w./sq.ft. Ratings provide for temperatures of 100°C. (type 1), 150°C. (type 2) and 200°C. (type 3). Types 1 and 2 are used for general applications and type 3 where a rapid temperature rise is required. Thermostats and pyrometers can also be supplied with the sheeting.

The sheeting is robust and will withstand considerable pressure. Data concerning pressures up to 1 ton/sq.in. is available from the makers. It produces even surface heating with a high degree of flexibility. It is well insulated and can be used under difficult working conditions where spillage may occur.

The sheeting is supplied in all lengths and in widths up to 6 ft. wide with a thickness of $\frac{3}{16}$ in. Standard sizes range from 12 × 6 in. to 96 × 48 in. (heated areas), but special sizes can be produced. It operates on 100/120 or 200/250 v., a.c. or d.c. mains, but can be supplied for other voltages. It has been tested for resistance satisfactorily at 2,500 v. a.c., and 1,000 v. d.c., when completely immersed in water. A production sample has operated continuously at 180°C. for over 2,000 hr. and still works efficiently. The standard sheeting takes 20 to 30 min. to reach maximum temperature and will thereafter maintain that temperature, but it can be designed to reach a specified temperature in a shorter period. This sheeting is being used for heating chemical apparatus, tanks, vessels, trays, pipes, etc., especially where spillage or fire is likely to occur, where rough handling is required or mobility of the heating sources is desired. It is also being used for quick setting of synthetic resin glues in the constructional industries.



A 3,500-gal. mixing vessel manufactured from Firth-Vickers F.M.B. quality stainless steel by Metaducts Ltd., for Parke, Davis & Co. Ltd. The vessel is fitted with stirrers operated by reduction gear. It is used in the preparation of the pharmaceutical tonic, 'Metatone,' which is mixed cold and then filtered.

Vacuum drying improved with oil reclaimer

Dehydration of streptomycin solution at temperatures which have no deleterious effect on the drug is carried out by the use of high-speed vacuum pumps at the New Brunswick factory of E. R. Squibb & Sons Ltd., according to *Drug and Cosmetic Industry*, 1952, 71, (2), 217. When dehydration of the solution has been completed, the dried antibiotic which remains in the vacuum oven is removed and a new charge of frozen streptomycin is inserted and the process repeated.

In the original pilot plant, the company found it impossible to maintain a steady rate of production because of the progressive contamination of the oil in the pump with moisture. Thus, over a 2- to 3-hr. period, pump efficiency would drop appreciably, culminating in a 15- to 30-min. shut-down when the oil was changed. When the output of streptomycin was expanded from pilot plant to full commercial production, with a group of rotary vacuum pumps and the necessary vacuum ovens and condensers, an oil reclaimer for continuous purification of the vacuum pump oil was added to ensure sustained peak production. This unit has a capacity of 50 gal./hr. and it removes both solid impurities such as carbon, sludge and abrasives and, what is most important in installations of this kind, moisture and other high-vapour contaminants. In this unit, dirty oil is first filtered through a bed of Fuller's earth or adsorbent clay, then subjected to the drying action of an electrically heated vaporiser and vacuum pump.

The continuous supply of clean oil thus afforded the vacuum pumps have obviated the need for stoppages. It is claimed to prolong the pump life and to save up to 98% of the lubricating oil used. Thus, by eliminating the three shut-downs, averaging 23 min. each for each 8-hr. shift, this pharmaceutical company have increased output by approximately 15%. Production has been increased further by the maintenance of pump efficiency throughout operation.

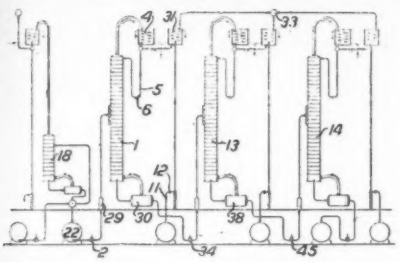
For further information on new plant and equipment please complete the coupon on page 628

Chemical Engineering Invention

MONTHLY SUMMARY OF PATENT CLAIMS

Controlling vacuum distillation

The composition of the top fraction in the vacuum rectification of mixtures of close-boiling, homologous compounds liable to be decomposed by heat, such as coal tar phenols, is controlled by keeping substantially invariable proportions between the rate of supply of feed (assumed to be of constant composition), the rate of reflux return, and the rate of discharge, from the system, of the condensate of the top fraction. The control is achieved by employing, in addition to the usual column with an adjustable boiler, an adjustable feed-pump, and by inserting flow-meters in the reflux and discharge conduits.



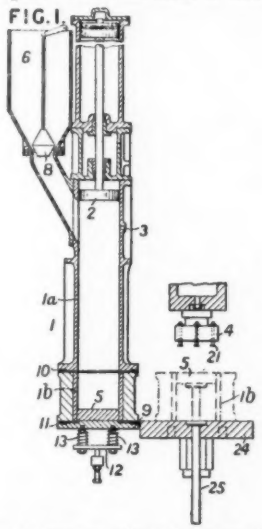
The flow-meters may be used, with the aid of relays, to make the regulation automatic. In the rectification of coal tar phenols, three columns 1, 13 and 14 maintained at a pressure of about 20 mm. by device 33, are employed. The phenols are freed from water, pyridine bases and neutral oils in auxiliary column 18 and then fed, by pump 2, from tank 22 into column 1 *via* preheater 29. The various adjustments are made so that the vapours of phenol itself (of at least 90% purity) pass out of the top of the column. These vapours are in part condensed in analyser 4, the remainder being condensed in cooler 31. The condensate from the analyser is returned to the column as reflux through conduit 5 which is provided with flow-meter 6. The condensate from the cooler is removed from the system through conduit 11 which is provided with flow-meter 12. The proportions refluxed and discharged are regulated by means of analyser 4, and the reflux ratio is maintained at the required value, *e.g.* the minimum necessary to maintain the purity of the top fraction, by adjusting the temperature of boiler 30. The residue leaving boiler 30 is fed by pump 34 into column 13, which has the same equipment as column 1, and from the top of which vapours of ortho-cresol are withdrawn. The residue leaving boiler 38 is fed by pump 45 into column 14 from the head of which meta-para-cresol is withdrawn. The feed pumps 2, 34, 45 are driven by the same transmission, the discharge of each being regulated as a function of the composition of the feed mixture. The invention may also be carried out using total condensers and reflux pumps in place of the analysers. Specifications 224,085 [*Class* 32] and 619,856 are referred to.—619,857, *Soc. pour l'Exploitation des Procédés-abder-Halden.*

Compacting carbon black

In compacting carbon black, *e.g.* lamp black, gas black and thermatomic black, the black is fed into a container from which air is withdrawn by suction through a port or ports so remote from the black that the velocity of air flowing from the black is so low that there is no tendency for the black to be entrained with the air leaving the container.

As shown in Fig. 1, carbon black is fed through a valved hopper 6 into a cylinder 1, *e.g.* until the latter is about half full, air is then evacuated through port 3, after which a hydraulically operated plunger 2 is lowered to compress the black into a removable lower portion 1*b* of the cylinder and air is re-admitted after the plunger has been raised. The portion 1*b* is slid on to a plate 24 and the black is briquetted by a hydraulic ram 4 at, *e.g.*, 2 tons sq.in. The ram head is then raised

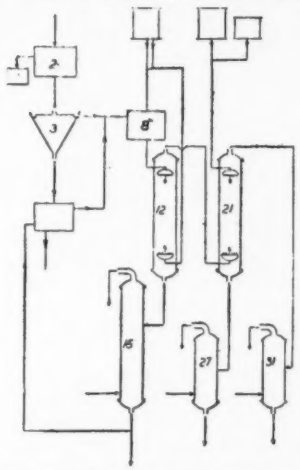
FIG. 1.



and the briquette ejected upwardly into a carton by rod 25, the bottom 5 of the cylinder portion 1*b* being slidable. The lower cylinder part 1*b* is sealed to its upper part 1*a* by gaskets 10 and 11 and a plate 9 held in position by pressure controlled hydraulically through a bar 12 and springs 13. To obviate compression of air by the ram head 4 in the lower part 1*b*, the head 4 contains air escape holes having closures 21 at their undersides which normally depend down, thereby allowing air to pass, but which, when they engage the surface of the black, are pressed up and close the holes. Four air evacuation and compacting cylinders, which may be square in cross-section, may be arranged to work in co-operation with one hydraulic ram. Specification 551,862 is referred to.—618,955, *C. H. Champion & Co. Ltd. and L. Koppel.*

Solvent recovery of fats

Wool-grease or other fatty matter and soap or synthetic detergents having a like effect are recovered from wool scourers' liquors or similar trade wastes, by agitating the liquors in the presence of a solvent composed at least partly of a polar compound or compounds and which is at least partially immiscible with water and is capable of dissolving the grease or fatty matter and soap or synthetic detergent



having a like effect. The solvents specified comprise fusel oil, amyl alcohols, normal- or iso-butyl alcohol, or cyclohexanol. The soap, etc., may then be recovered from the extract solution by washing with water, with or without addition of another substance such as a petroleum fraction to decrease the solubility of the soap, etc. The soap, etc., and the fatty matter are finally obtained from the aqueous solution and the remaining extract solution by removal of solvent respectively.

The liquor separated from the first extract solution is regenerated scourers' liquor and may be re-used. In a suitable plant applied to wool scourers' liquors, the liquor is passed through a screen 2 and a sand-settling tank 3, to a mixing tank 8 for optional treatment with a small proportion of fusel oil or butanol to break the emulsions prior to the main solvent extraction preferably by counter-current in a column 12. The fusel oil or butanol in the latter are preferably used in the proportion of at least two parts by volume

(*Concluded on page* 628)

World News

GREAT BRITAIN

Shawinigan may produce in U.K.

The Canadian company, Shawinigan Chemicals Ltd., is considering producing chemicals in the sterling area. Mr. V. G. Bartram, president, informs us that the whole problem is still being investigated and the economics of producing in S. Africa as opposed to producing in the U.K. are being studied. He says that for some products they have in mind the U.K. may have the advantage of lower cost, since the cost of packaging and transportation from S. Africa to the U.K. market must be considered. Industrial chemicals based on calcium carbide will be manufactured, but no definite plans have been made.

Another dry seal gasholder erected

The second Wiggins dry seal gasholder to be built in the U.K. has just been completed at an oil storage depot in the north of England by Ashmore, Benson, Pease & Co. This holder is the same size as the 10,000-cu.ft. gasholder erected at Alston, in Cumberland, within the last year for the Northern Gas Board.

In the U.S.A. a large number of these holders have been in operation for several years and more are being built.

New Vacuum Oil refinery

It is expected that some of the units at the Coryton Refinery of the Vacuum Oil Co. Ltd. will be in operation before the end of the year and that full production will be attained by next summer. Some 95% of the materials, plant and equipment used in its construction are of British manufacture and the Powell Duffryn group have helped considerably in its procurement. A *Thermofor* catalytic cracker, designed in accordance with the most modern developments of the Socony-Vacuum Oil Co. Inc., is being installed, facilitating the production of high-quality motor spirit and lubricating oils. Last March the water-intake caisson was installed. It is designed to provide the refinery with 45 million gal./day water.

This company is also modernising its two lubricating oil plants. At Birkenhead, reconstruction of the 420,000-gal. lubricating oil compounding and blending plant was started in 1948 and completed recently. The main feature is the multi-compartment tank designed to effect economies in and to facilitate storage and distribution of finished products. Covering an area of 6,400 sq. ft., this is the largest unit of its kind in Europe.

Certain preliminary work has been started on the modernisation of the Wandsworth compounding and blending plant.

During the 1951 financial year, Vacuum spent over £3 million on projects in the course of completion.

Monsanto cut prices to maintain turnover

An interesting glimpse of current trading conditions in the chemical industry is given by Monsanto Chemicals Ltd. in a statement accompanying a declaration of a $6\frac{2}{3}\%$ (4d. per 5s. unit) ordinary interim dividend, paid on November 1. Monsanto have consistently and strikingly increased their profits for the past few years. In 1951, for instance, net profits were £945,976, compared with £581,536 in 1950.

The interim statement refers to increasingly severe deflationary conditions and continues: ' However, the company's turnover for the first eight months of 1952 is slightly in excess of that for the similar period of 1951. The turnover, however, has been less than your board anticipated, and trading profits have been materially affected by the necessity for reducing prices. Approximately one-third of your company's turnover is traditionally direct exports and, although this percentage has not only been maintained but in fact slightly increased, prices in many directions have had to be substantially reduced to meet severe foreign competition. Similarly, in the home market, reductions have been necessary to maintain turnover and to meet the needs of our consumer industries for a more competitive basis for the sale and export of their own products.

' In some directions there have been, during the past few weeks, indications of a rather more encouraging nature, but it would be imprudent at this time to attempt to predict the results for the full year.'

I.C.I. director heads industrial mission

A party of British industrialists recently visited Jamaica, Trinidad, British Guiana and Barbados to investigate the possibilities of further industrial development in those areas. The party was lead by Mr. Lincoln Steel, a director of Imperial Chemical Industries Ltd. since 1945.

Mr. Steel joined Brunner Mond & Co. Ltd. in 1922. Ten years later he became a delegate director of I.C.I. (Alkali) Ltd. and in 1942 managing director of the I.C.I. Alkali Division. A year later he was appointed chairman of this Division. As a full director he is now responsible for the Heavy Chemicals Group.

Mr. Steel is also chairman of the British National Committee of the International Chamber of Commerce and chairman of the Overseas Trade Policy Committee of the Federation of British Industries.

Metal controls relaxed

Licences are no longer required (as from October 1) for the acquisition and use of lead, lead alloys, lead scrap and residues, remelted zinc, zinc alloys, zinc scrap and residues, copper scrap and residues, and copper alloy scrap and residues, according to a Ministry of Supply announcement.

However, licences are still required for the acquisition of unwrought copper and virgin zinc, and copper and zinc ores and concentrates. The restrictions on the use of copper and copper alloys in the manufacture of certain articles remain in force.

Tungsten and molybdenum allocations

Supplies of tungsten and molybdenum have been under international control since July 1, 1952. Although production has increased since then, both continue to be in short supply. The total ' Free World ' production of tungsten for the fourth quarter of 1952 is estimated by the Tungsten and Molybdenum Committee of the International Materials Conference at 4,957 metric tons metal content, and the ' Free World ' production of molybdenum at 5,680 tons metal content. The tungsten estimate shows an increase of 37% as compared with the actual production rate in the second half of 1951, and is more than double the 1950 production rate. The molybdenum estimate shows an increase of 15%, as compared with actual production in the second half of 1951, and is over 50% above the 1950 rate.

Allocation figures for the fourth quarter of 1952 show that the U.K. will receive 990.6 tons tungsten, compared with the U.S.A. 2,510 tons, Germany 440 tons and France 363 tons, in the form of ores and concentrates and is estimated to export 80 tons of primary products, compared with Sweden 73 tons and Germany and France 42.3 tons each. Supplies of ores and concentrates will come chiefly from Asia (excluding Japan) 825 tons, Portugal 700 tons and Bolivia 600 tons.

Similarly the U.K. has been allocated 420 tons molybdenum, compared with the U.S.A. 4,202.6 tons, France 304 tons and Germany 270.5 tons, in the form of ores and concentrates. U.K. exports of primary products are estimated at 30 tons, compared with the U.S.A. 128 tons, France 65 tons and Germany 57 tons. Chief sources of molybdenum are Chile 671 tons and the U.S.A. 522.5 tons.

Polythene cistern float

Two companies, Fordham Pressings Ltd. and G. & E. Equipment & Contracts Ltd., are combining forces to produce a polythene cistern float which is expected to supersede the conventional copper ball. It is claimed to be cheaper and to have a very long life.

G. & E.'s polythene processing plant has recently been moved from Mill Works, Ruislip, to Wolverhampton. It can accommodate mouldings up to 5 lb. in weight, these being some of the largest produced in the U.K. The company also claim that their polythene acid bucket, which is resistant to most corrosives, can be supplied at a fraction of the cost of stainless-steel buckets.

New carburetted water gas plant

The new carburetted water gas plant at the Beckton gas works of the North Thames Gas Board has a gas-making capacity of 18 million cu.ft. day.

The plant is the latest of its type and consists of four back-run sets with 9-ft. diameter dry sealed generators. Steam is raised in the waste heat boilers at 300 p.s.i. and superheated to 500 to 650°F., and is expanded through a pass-out turbo-alternator of 1,400 kw. capacity before supplying the process requirements at 7 p.s.i. Two steam accumulators are provided between the turbine pass-out and the process main to smooth out the varying rates of steam production and demand.

The plant is designed to give a high thermal efficiency with high blast pressures, and the steam and power system has been co-ordinated so that the plant is virtually self-supporting in its steam requirements, while there is a surplus of electricity which is exported to the works system.

Beckton works is highly mechanised and there is some 15,000 h.p. of direct steam-driven machinery, together with more than 1,100 electric motors, having a connected load of nearly 20,000 h.p., for driving mechanical equipment and other plant.

A new boiler house has been built which incorporates the latest features for giving a high fuel efficiency and flexibility of control. The house contains four mechanically fired water-tube boilers arranged for burning coke breeze. Each unit has an evaporative capacity of 40,000 lb. hr. at the pressure of 300 p.s.i. and temperature of 750°F. The eventual operating pressure is 500 p.s.i.

The new boilers replace a number of existing units installed 35 to 40 years ago.

The new mechanical workshops at the Products Works take the place of the old, obsolete and scattered units, and most of the 400 men engaged in maintaining the chemical process plants will be accommodated, together with engineering stores, on a floor space of about 80,000 sq. ft. When completed, general maintenance both for the Products Works and the board's manufacturing stations will be undertaken here.

U.S. firms offer licences

Fifty new licensing proposals for the foreign manufacture of American products have recently been announced by the Mutual Security Agency to the U.K., bringing the total number of proposals to 277. Among the new companies wishing to appoint licensees are: J. Ashton Green & Associates, Baton Rouge, Louisiana, services in petroleum, natural gas and petroleum chemicals; Bush Manufacturing Co., West Hartford, Connecticut, refrigeration, air-conditioning and heating products; Calcumite Co., Hamilton, Ohio, techniques of glass treatment; Centro Research Laboratories, Inc., New York City, technical knowledge of chemicals, paints and rubber-base finishes; Chemit Co., Brooklyn, New York, chemical manufacturing consultants; Continental Industrial Engineers Inc., Chicago, furnaces, driers and other plant; No-Rust Chemical Corporation, Chicago, vapour wrapper for protecting machinery during storage; Petroleum Technologists Inc., Montebello, California, petroleum production consultants; Pittsburgh Annealing Box Co., Pittsburgh, circular annealing inner covers for steel protection; Scott & Williams Inc., New York, patented hydraulic pump; Samuel Smidt Chemical Corporation, Peabody, Massachusetts, leather finishes and latex-type paints; and Ultra-Cold Inc., Los Angeles, California, refrigeration equipment.

Change of address

The Gawber office near Barnsley of Coalite and Chemical Products Ltd. has now closed and all correspondence should be addressed to the company at P.O. Box 21, Chesterfield, Derbyshire. This move is part of a scheme for the concentration of the headquarters of the Coalite companies in a new building at Bolsover, near Chesterfield.

The London office at 82 Victoria Street, S.W.1, is being retained.

Directory of Board of Trade

A 16-page directory of Board of Trade departments and their work is now available. It is divided into three sections namely (1) addresses of B.o.T. departments; (2) alphabetical index of subjects dealt with by the B.o.T., with the appropriate division or branch and telephone number; and (3) main production departments and the commodities for which they are responsible.

D.S.I.R. reports on plastics

Twenty-one research reports are included in the volume 'Plastics,' published recently by the D.S.I.R. (H.M.S.O., price £1 15s. 11d., including post). They describe research which was carried out during the war by the Ministries of Supply and Aircraft Production.

The reports cover the investigation of the mechanical properties of high polymers and their behaviour during manufacture and in use.

Personal

Mr. G. A. T. Burdett has joined Holophane Ltd. as publicity manager in succession to Mr. R. J. W. Briddon, who now represents the company in the south-western area.

Dr. J. E. Taylor has been invited to join the board of Joseph Crosfield & Sons Ltd., following the expansion of the company recently. Dr. Taylor is a graduate of Leeds University. He joined the British Oil & Cake Mills at Selby in 1934 and since 1946 has been with the Technical Division of Unilever Ltd. He will be taking up his new appointment towards the end of the year.

New Advisory Council members

Sir Wallace Akers and Sir Philip Johnson have been appointed members of the Advisory Council for Scientific and Industrial Research by the Lord President of the Council.

Sir Wallace Akers is a director of Imperial Chemical Industries Ltd. and Sir Philip Johnson is a director of Hawthorn Leslie & Co. Ltd. and chairman of the Parsons & Marine Engineering Turbine Research & Development Association.

Prof. P. I. Dee retired from the Council on September 30 and Sir Hugh Warren has resigned because of the pressure of other duties.

Harwell isotopes for 37 countries

Britain is now the biggest exporter of radioactive isotopes for peaceful purposes. Altogether 9,573 consignments of isotopes were sent from Harwell to 37 different countries during the year ending June 1951. Some 3,053 went overseas by air. The British Overseas Airways Corporation have converted a fleet of Argonauts to carry the materials in their wing tips, thus reducing the cost of transport by over 60% by cutting out the heavy lead containers. Similar modifications to Comet 2 aircraft are being considered.

To date 133 experienced scientists, engineers and doctors have passed through the Harwell Isotope School. Of these, 102 have come from the U.K. and others from India, Australia, S. Africa, Belgium, Egypt, Greece, Holland, Israel, Italy, Norway, Spain, Sweden and Yugoslavia. Nearly two-thirds have been chemists.

Q. & Q. prosper

Speaking at the recent annual general meeting of the Triplex group of companies in London, Sir Graham Cunningham, chairman and managing director, said that the subsidiary company, Quickfit & Quartz Ltd., manufacturers of industrial and scientific chemical glassware, had increased its turnover considerably during the year, namely from £252,531 to £344,982.

Flexible tubing service

An advisory and supply service covering flexible tubing and hoses of all kinds has been established by Compoflex Co. Ltd. at their new London showrooms. Here samples and installation photographs of hundreds of different 'flexibles' can be seen. The company's representatives are also available to advise manufacturers on all matters concerning the use of flexible tubing and hose.

HUNGARY

Bentonite deposits exploited

A factory will shortly be opened for the large-scale processing of bentonite. A bentonite factory is already in operation at Mád in north-east Hungary. In 1949 a Bentonite Research Committee was set up. Hungarian bentonite deposits are now believed to be almost as great as the country's extensive bauxite deposits.

FINLAND

New nitrogen factory ready

The new nitrogen factory at Oulu is expected to be in full production soon. In the process used, the ammonia is first produced from powdered coal and atmospheric nitrogen and converted first into nitric acid, then ammonium nitrate and finally into 'nitro-chalk.' The air distillation, gasification and ammonium works started operation in August and other plants are being brought successively into operation.

The production capacity of the factory is 16,000 metric tons p.a. nitrogen, but it is said that this could easily be doubled. Present raw material requirements amount to 40,000 tons coal and 20,000 tons limestone p.a. The factory is described in *Teknillisen Kemian Aikakausilehti* (1952, **9**, (15-16), 371-374), official journal of the Finnish Central Chemical Association.

FRANCE

International chemical meetings

A number of congresses and symposia of interest to the whole of the chemical industry are being held in Paris from June 18-29, 1953. The main event is the 26th International Congress of Industrial Chemistry which will be divided into 22 sections each dealing with a different subject or aspect. Other technical meetings include the 1st International Congress of Corrosion, 7th International Congress of Esthetics and Cosmetology, 2nd Chemical Engineering Symposium and the annual meeting of the German Chemical Plant Manufacturers' Association (DECHEMA).

The 2nd Chemical Exhibition and the 8th Exhibition of Laboratory Equipment and Industrial Instruments will be held at the same time. The exhibition will be presented in five groups, namely instruments and instrumentation; chemical engineering covering standard equipment, special plant and an out-of-doors section; industrial and fine chemicals; industrial administration and management including classification, standardisation, accident prevention and hygiene, etc.; and finished products including paints, printing inks, rubber articles, plastics and perfumes. Visits to industrial establishments will also be arranged.

New steel plant completed

The big steel works of the Sollac company in the vicinity of Thionville, near the Luxembourg border, begun in 1949, has now been completed. The works is equipped with one continuous hot-rolling mill and one continuous cold-rolling mill for steel and tin plate and operations will start soon. Preliminary tests have given satisfactory results. Besides blast furnaces and continuous rolling mills, the works include a modern steel-producing plant and a coking plant which is to use fine coal from Lorraine.

With Hayange ore only 3 km. from the blast furnaces and the Lorraine coal deposits only 50 km. away, the Sollac works are well situated to produce at low cost. An annual production of 600,000 tons p.a. of steel plate is expected.

When Sollac and Usinor, the other big northern steel works, are operating at full capacity, France will have an exportable surplus of 200,000 tons, or 17% of her annual production of steel plate.

Chemical plant for S. America

The French heavy engineering company, Société Française Batignolles-Chatillon, has received an order amounting to over $3 million from Brazil to supply equipment for a plant for the production of ammonia and hydrogen. Another French concern, Air Liquide, and the U.K. firm of Babcock & Wilcox will also participate. The plant will be erected near the Santos petroleum refinery, which was also built by French firms, including Schneider and Fives.

Batignolles further announced that it has founded, together with the French firm, Neyret-Beylier, a subsidiary, Batyneyret, which is now negotiating with the Peruvian authorities to set up a newsprint mill there. The mill would be situated in the upper valley of the Amazon and would produce newsprint from fibres of a tropical tree which grows there in abundance. Industrial tests made in France proved that this wood can be used for the production of newsprint of excellent quality.

The plant would be built for the Peruvian Central Bank, which is entrusted with the exploitation of the natural resources of this area. The total value of the equipment to be supplied would be $7 million. Besides the above two companies, the French firms Alsthom Compagnie Generale d'Entreprises Electriques and Entreprises Metropolitaines et Coloniales would participate in the building of this plant.

AUSTRIA

Non-ferrous metals output

In the first half of 1952, non-ferrous metal works produced 4,200 tons of soft lead (4,400 tons in the same period of 1951), 670 tons of hard lead (824 tons), 16,800 tons of virgin aluminium (12,800), 3,021 tons of electrolytic copper (3,083 tons) and 1,200 tons of refined copper (1,340 tons).

At present a series of capital investment projects is being carried out. The Brixlegg copper works are extending their electrolytic plant, the new zinc works of the Bleiberg Mining Union is in course of erection, while the Salzburg aluminium works in Lend is enlarging its hydroelectric power plant.

The Oesterreichische Metallwerke at Ranshofen have recently been able to increase exports of semi-finished aluminium products, the Caro Works have done the same with their special bronzes and the Plansee metal works in the Tyrol have considerably increased exports of sintered products.

GERMANY

Equipment in exchange for Rumanian chemicals

East Germany is to develop Rumania's chemical industry under an agreement recently signed in Berlin. The agreement envisages the formation of an East German Rumanian company, in which each of the two countries would have a half share, for the purpose of developing the chemical industry in Rumania by utilising domestic raw materials.

East Germany would supply Rumania with equipment for the metallurgical and timber industries in exchange for ores and metallurgical, chemical and timber products.

NORWAY

Niobium discovered

Niobium, hitherto found almost exclusively in Nigeria, has been discovered at Söve, in Telemark. Arne Drægseth, director of Norsk Bergverk A/S, the Norwegian Government's mining corporation, states that a satisfactory method of processing the ore has also been discovered, and that operations on an experimental scale will begin soon. A pilot plant is being established, and it is intended provisionally to process about 40,000 tons of raw ore a year, and produce about 150 tons of niobium concentrate with a 50% content.

The U.S. has now fixed a price for niobium which will ensure very good profits. This price will be in force for the next five years. There is also no danger that the demand for niobium will drop, as American calculations show that demand is 20 times greater than the supply.

A million tons of pyrites

Production at the rate of 150,000 tons p.a. of copper pyrites started at the Skorovass mines in north Norway last month. The mines employ 170 men. The Norwegian Government guaranteed a loan of £650,000 for the reconstruction of the mines. Nearly the whole output is to be exported.

Norway's production of pyrites last year was 700,000 tons, and the Skorovas mines will help to increase total production to the 1 million tons which was the annual rate before the war.

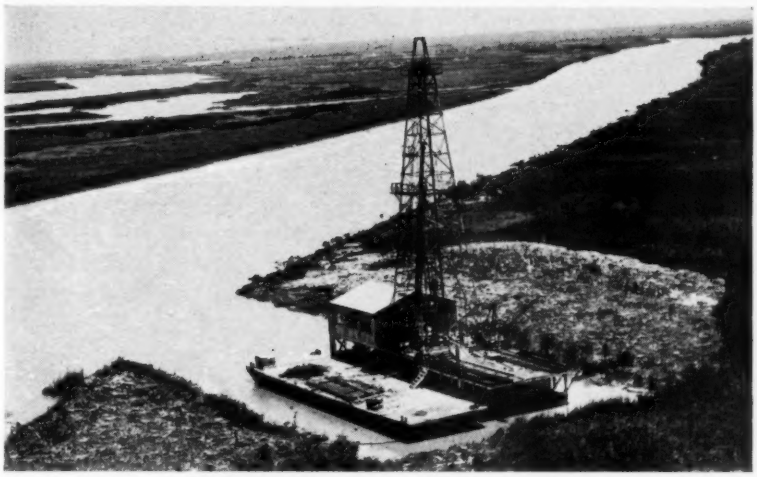
BRITISH WEST INDIES

CO_2 plant working

The Jamaican Sugar Manufacturers Association's carbon dioxide plant, which commenced operations twelve months ago, is now in full production and is supplying Jamaica's requirements of approximately 350,000 lb. p.a.

Bauxite now exported

The first shipment of bauxite left Ocho Rios, on the north coast of Jamaica, several months ago for processing at Reynolds Metals Refinery in Alabama.



SULPHUR IN THE MISSISSIPPI DELTA

At Garden Island Bay in the marshes of the lower Mississippi river delta, 100 miles south-east of New Orleans, the Freeport Sulphur Co. claims to have discovered the largest sulphur deposit located in the past 20 years. To develop the deposit the company is to build a mining plant with a production capacity of 500,000 long tons of sulphur p.a. at a cost of between $10,-15,000,000. The plant is expected to be ready for operation in 1953. The above photograph shows a floating rig of test drills for locating the sulphur. The deposit is native sulphur or brimstone and it occurs in a typical salt dome formation. It was discovered by the Texas Co. in prospecting for oil. Freeport obtained the sulphur rights early in 1951 and under the agreement it will pay the Texas Co. 50% of the sulphur mining profits.

There are now four bauxite undertakings in Jamaica, the newest company, of U.K. origin, being formed only last August. It is expected that a considerable amount will be shipped in due course to British Columbia, where a $550-million project is being undertaken by the Aluminium Co. of Canada.

UNITED STATES

$2 million for salt water demineralisation

Research is to be undertaken on means to bring down costs of making fresh water from salt water to supply industries, cities and farms in water-short areas of the U.S.A. which have access to seas or other salty water sources. Congress has authorised the sum of $2 million for a five-year period for this purpose, provided departmental expenses for the correlation and coordination of information over the same period do not exceed $500,000.

Currently known processes are said to be too expensive for the large-scale production of by-product chemicals, but it is expected that a method will be developed which will help to offset the cost of water production.

The work will be carried out through research grants and contracts to educational institutions, scientific organisations or industrial or engineering firms in cooperation with Government departments. It is expected that the U.S. Bureau of Mines will participate in an advisory capacity, giving technical assistance to the Bureau of Reclamation when necessary. Notes on the extraction of minerals from the sea water were given in this journal, 1951, **32**, 219, 261 and 364.

Water-repellent silicone

A new silicone chemical, sodium methyl siliconate, has been developed by the General Electric Co., U.S.A. This silicone is claimed to have the commercially unique combination of water solubility and water-repellency. Because of its water solubility it can be incorporated with concrete, during mixing, as a masonry water-repellent. It can be used also as a water-repellent for pipe insulation materials and has possibilities as a water-repellent for textiles, paper products and powdered materials. Although General Electric will be the first company to produce sodium methyl siliconate commercially, other companies have carried out research on it.

According to *Chemical Week* (1952, **70**, (6), 24), a possible disadvantage is that water solutions of the sodium salts of silicones have a high *p*H which could be hazardous to spray operators and might cause corrosion problems with certain types of masonry.

Sodium methyl siliconate can be made from basic chlorosilanes with caustic or soda ash, though the exact method employed by General Electric is not disclosed.

New sulphuric acid plant

The U.S. Eagle-Picher Co. will begin construction in the near future of a $4 million zinc-roasting and sulphuric acid plant at Galena, Kansas. The project is due for completion early in 1954.

Output of sulphuric acid is scheduled at 240 tons/day, the major part of which will be sold under a long-term contract to the Missouri Farmers' Organisation, which will build a phosphoric acid and fertiliser plant near the site of the new project.

Uranium from phosphate plants

The first commercial unit in the U.S. for the recovery of uranium from phosphate rock has begun operations, according to the Atomic Energy Commission. It said the unit was part of the factory of the Blockson Chemical Co., near Joliet, Illinois. The company did the research and engineering on the unit and had a contract to supply to the Commission the recovered uranium. The company operated a factory for production of phosphate chemicals and the uranium recovery process would be carried on in conjunction with it. Phosphate rock from Florida was used.

The Commission's announcement said three other companies were building full-scale recovery plants. International Minerals & Chemical Corporation and Virginia-Carolina Chemical Corporation were incorporating uranium discovery units into factories now under construction near Mulberry, Florida, and Texas City Chemicals Inc. was building a recovery unit at Texas City, Texas.

The Commission gave no indication how much uranium it expected to be produced by the factories or how the cost compared with that of uranium mined by other methods. It merely said that the recovery process had been found to be feasible.

Fertiliser plant modernised

U.S. fertiliser output will be increased considerably next year when a plant operated by Associated Cooperatives Inc. goes into production. The plant, originally erected during World War I for the production of explosives, is being modernised at a cost of around $2 million. It will produce nitric phosphate fertiliser at a rate of some 60,000 tons p.a. and about 60 tons/day of nitric acid.

Warnings labels for bulk chemicals

To stimulate satisfactory uniform labelling of chemical products, a Public Health Service Committee is being reactivated to work with the Manufacturing Chemists Association, according to Oscar R. Ewing, Federal Security Administrator.

Since the 1930s, when agreements between the Public Health Service and certain chemical manufacturers were drawn up, the use of potentially hazardous chemicals has greatly increased and many new products not covered by the agreements have been introduced. Agreements with manufacturers of methanol, carbon tetrachloride and other chlorinated hydrocarbons, carbon disulphide, aniline, benzene and chlorinated naphthalenes, diphenyls and diphenyl oxides, covering warning designations to be used on containers, are now therefore being discontinued.

The new labelling programme has been

developed for bulk packages of chemicals intended for commercial use. It in no way affects the provisions of the Federal Caustic Poison Act, which applies to some caustic and corrosive chemicals intended for household use, or the Federal Food, Drug and Cosmetic Act, which requires adequate warnings on the labels of all drugs.

Industrial mineral resources

What is believed to be the most complete inventory to date of the industrial mineral resources of the Pacific north-west states—Oregon, Washington, Idaho and Montana—is contained in a report issued recently by the Bureau of Mines, U.S. Department of the Interior. The report gives the location, by states and counties, of deposits of each of the following mineral commodities: abrasives (garnet, corundum and silica), asbestos, barite, bauxite, cement materials (including brick and tile), clay, diatomaceous earth, feldspar, fluorspar, gem materials, graphite, gypsum, limestone, magnesium minerals, mica, mineral wool, peat, phosphate rock, quartz crystal, refractories, sand and gravel, stone, talc and vermiculite.

MEXICO

Sulphur deposits to be worked

Some of the richest deposits of elemental sulphur in the world which can be operated by the Frasch process from brimstone have been discovered by the Gulf Sulphur Co., according to Mr. R. A. Vandoren, president. The company will soon have drilled some 40 test wells in its Mexican properties and one well has a thickness of more than 276 ft. of commercially exploitable sulphur-bearing layers. A Frasch process plant is expected to be constructed in the near future.

Petrol and lubricant plants

A new petroleum desulphurisation plant went into operation a few months ago at Mexico City. The present output of 128,000 litres/day of 80-octane petrol is expected to be increased to 384,000 lb. when in full production shortly.

A 170-million-peso lubricants plant will be completed this year at Salamanca. It will have a capacity of 2,200 barrels/day, covering all grades of lubricants and allowing some for export.

Chemical, cellulose and cement plants

A caustic soda factory, and fertiliser and insecticide plants are among the projects to be started in the Salina Crux area. Japanese interests are said to be investing over 150 million pesos in these developments.

A plant for the manufacture of transparent cellulose paper has recently come into operation. Its capacity is said to be 6,000 metric tons p.a., but present production is at the rate of 2,000 tons, which is expected to avoid the need for imports.

An 8-million-peso cement plant is to be established in the Guerrero State and plans have been approved by the Government. Mexican cement production for 1952 is estimated at 2 million metric tons.

Synthetic fibre output

It is estimated that 32.5 million lb. synthetic textile fibres will be produced this year in Mexico, compared with 24 million lb. in 1951 and 20.5 million lb. in 1950.

SOUTH AFRICA

Uranium production started

The production of uranium in the Union is starting at 13 gold mines. The first plant to operate, West Rand Consolidated, was opened by the Prime Minister, Dr. Malan, on October 8. The other mines engaged in similar projects are the Randfontein Estates, Luipaardsvlei, Virginia G.M., Free State Geduld, President Brand, President Steyn, Welkom, Western Holdings, Daggafontein, Blyvooruitzicht, Western Reefs and Stilfontein mines (see this journal, 1951, **32**, (1), 12).

Uranium production will also be possible at the Bird Reefs and South Main mines, which produce a total of 140,000 tons/month of gold mine residue slimes and, in order to handle this output, the Turk crushing plant with the present capacity of 110,000 tons/month will be extended. A further two plants owned by the Anglo-American Corporation of South Africa Ltd. will be erected in the Welkom area, to handle 100,000 tons/month of slime.

At present the Union intends to export all its uranium, but it will retain as much as it needs for its own purposes. Production figures for uranium are not available, but it is reported that £50 million is being spent on the development of uranium from slimes on the Rand, the cost of the West Rand Consolidated project amounting to £1,600,000. It is expected that all 13 mines involved will be in full production by 1955.

Acids and alcohols from wool grease

Research at the S. African National Chemical Laboratory has led to the economical recovery of acids, alcohol and cholesterol from wool grease.

Whereas raw rool grease is worth about £5 per 100 lb., the products resulting from the chemical treatment of the grease are worth about £67 per 100 lb. It is believed that some 4 million lb. of grease can be recovered from the 80 million lb. of wool washed annually in the Union.

EL SALVADOR

Cement industry expands

The cement plant under construction near Acajutla is expected to commence production soon.

A plant manufacturing flat and corrugated asbestos-cement sheets commenced production a few months ago.

AUSTRALIA

Work on largest refinery started

Work on the Anglo-Iranian Oil Co.'s new refinery at Kwinana, near Fremantle, started on October 1, marking the inauguration of a three-year building programme at a cost of £A40 million. Simultaneously a programme of housing and the dredging of Cockburn Sound to provide the necessary approach by tankers is being put in hand by the Western Australian authorities.

The refinery is expected to come into operation late in 1955 and will process 3 million tons p.a. of crude oil from the Middle East. It will be the largest oil refinery in Australia and is expected to provide 40% of the country's oil requirements.

Two new pyrites sulphuric acid plant

Contracts for two Simon-Carves Monsanto contact sulphuric acid plants have been received by the Australian subsidiary of the U.K. firm of Simon-Carves Ltd. A 300-tons/day acid plant provided with the company's flash roasting system is to be erected at Port Adelaide. The plant will process local pyrites, available in large quantities, for the manufacture of acid which will be used in superphosphate works. The work involved will be carried out partly in the U.K. and partly in Australia and the project is expected to be completed in 2½ years.

The second plant is for Cockle Creek. It has a capacity of 100 tons/day and will have the new turbulent layer roaster system for the treatment of incoming pyrites.

New ammonium sulphate plant

A fertiliser plant being built in S. Tasmania at a cost of more than £3 million will produce half of Australia's annual consumption of ammonium sulphate. The plant is being built by the Electrolytic Zinc Co. of Australia and by the end of 1954 production should be 55,000 tons p.a. of ammonium sulphate.

CANADA

North American Cyanamid's HQ

North American Cyanamid Ltd. has consolidated its several office and warehouse locations in Montreal into one newly constructed building where it will increase its scope of activities by producing pharmaceuticals and refining aureomycin. The firm is a subsidiary of American Cyanamid.

Production at the new plant is scheduled to begin this month, and it is hoped will make North American Cyanamid independent of imports of many pharmaceutical items from the United States.

The new building will be Quebec headquarters for greatly expanded distribution facilities of a wide range of chemical products and the beginning of what may become a sizeable manufacturing operation in the medical and other fields.

MEETINGS

Institution of Chemical Engineers

November 11. ' Elimination of Carryover from Packed Towers—with Special Reference to Water Cooling Towers,' by H. Chilton, 5.30 p.m., Geological Society, Burlington House, Piccadilly, London, W.1.

November 15. 'The Vulcanisation of Thick Sheets of Rubber,' by E. C. Bott, 3 p.m., College of Technology, Manchester.

December 6. ' Efficiency of the Kaskade Distillation Column,' by F. H. Garner, S. R. M. Ellis and A. J. Hugill, 3 p.m., The University, Edmund Street, Birmingham.

GRADUATES' AND STUDENTS' SECTION

November 7. 'Agitation,' by Prof. Shelby-Miller, 6.15 p.m., Middlesbrough.

November 14. ' Naphtha Reforming,' by D. J. Hardie, 6.30 p.m., Caxton Hall, Westminster, London, S.W.1.

November 19. Discussion on the Home Paper Examination, 6.30 p.m., The University, Edmund Street, Birmingham.

November 20. ' Some Recent Developments and Applications of the Fluidised Solid Technique,' by S. Hesling, 7 p.m., Technical College, Huddersfield.

November 21. ' Filtration,' by Prof. Shelby-Miller, 6.15 p.m., Chemical Engineering Department, Stephenson Building, Claremont Road, Newcastle-on-Tyne.

November 21. ' Problems of Plant Design for Fluidised Processes,' by S. A. Gregory, 7 p.m., Queen Hotel, City Road, Chester.

December 4. 'Account of the Factors Affecting the Efficiency of Bubble-Cap Distillation Columns,' by J. E. Bartle, 7 p.m., Technical College, Great Horton Road, Bradford.

Society of Chemical Industry

CHEMICAL ENGINEERING GROUP

December 4. ' Selection of Lubricants for Industrial Applications,' by H. E. Priston, 6.30 p.m., The University, Bristol.

CORROSION GROUP

November 20. Symposium on Caustic Cracking in Steam Boilers, 9.45 a.m. and 2 p.m., Institution of Mechanical Engineers, Storey's Gate, St. James Park, London, S.W.1.

FOOD GROUP

November 26. ' Science, Industry and Society,' by the Earl of Halsbury, 6.30 p.m., Chemical Society, Burlington House, Piccadilly, London, W.1.

PLASTICS AND POLYMER GROUP

November 12. ' Polytetrafluoroethylene,' by Dr. W. C. Fergusson, Imperial Chemical Industries Ltd., 6.30 p.m., Mason Theatre, The University, Edmund Street, Birmingham.

November 24. Discussion on Polymer-solvent Interaction: ' Solvent Action of Organic Compounds for Polyacrylonitrile,' by Dr. E. E. Walker; ' Plasticisers,' by H. Jones, Geigy Co.; 6.30 p.m., Royal Society of Tropical Medicine and Hygiene, Manson House, 26 Portland Place, London, W.1.

ROAD AND BUILDING MATERIALS GROUP

November 20. ' Cement Aggregate Interaction in Concrete,' by Dr. F. E. Jones, Building Research Station, 6 p.m., the Building Centre, Store Street, Tottenham Court Road, London, W.C.1.

Chemical Society

November 10. ' Herbicides and Insecticides,' by Prof. G. E. Blackman, 8.15 p.m., Physical Chemistry Laboratory, South Parks Road, Oxford.

November 12. ' Chemical Engineering,' by Prof. D. M. Newitt, 7.15 p.m., Queen's University, Belfast. Joint meeting with the R.I.C. and S.C.I.

November 13. ' Self-sustained Exothermic Chemical Reactions with Special Reference to Explosions and Jet Propulsion,' by Dr. J. Taylor, 6.30 p.m., College of Technology, Manchester. Joint meeting with the R.I.C. and S.C.I.

November 20. ' Pile-produced Isotopes,' by Dr. W. J. Arrol, 7 p.m., The University, Bristol. Joint meeting with the R.I.C. and S.C.I.

November 21. ' Some Recent Work on the Chemistry of Metallic Oxides,' by Dr. J. S. Anderson, 7.15 p.m., The University, Glasgow.

November 21. ' The Molecular-orbital Theory of Organic Chemistry,' by Prof. M. J. S. Dewar, 7.45 p.m., Trinity College, Dublin, Eire.

November 24. ' Industrial Catalysis,' by Dr. D. A. Dowden, 8.15 p.m., Physical Chemistry Laboratory, South Parks Road, Oxford.

November 25. ' Chemistry of the Tropolones,' by Prof. R. D. Haworth, 6.30 p.m., The University, Leeds.

November 25. ' Some Recent Advances in the Chemistry of Natural Products,' by Dr. W. B. Whalley, 7.45 p.m., Queen's University, Belfast. Joint meeting with the R.I.C. and S.C.I.

November 27. ' Phosphates and their Application to Industry,' by C. W. Todd, 7 p.m., The University, Bristol. Joint meeting with the R.I.C. and S.C.I.

November 27. ' Kinetics of Halogenation of Organic Compounds,' by R. P. Bell, 5 p.m., Chemistry Lecture Theatre, The University, Liverpool. Joint meeting with R.I.C., S.C.I. and British Association of Chemists.

November 27. ' Some Organometallic Compounds containing Fluorocarbon Radicals,' by Prof. H. J. Emeléus, 4.45 p.m., The University, Nottingham.

December 3. ' Textile Fibres—Variations on Some Familiar Themes,' by J. R. Whinfield, 7.15 p.m., Queen's University, Belfast. Joint meeting with the R.I.C. and S.C.I.

December 4. ' Some Recent Advances in the Chemistry of the Fluorine Compounds,' by Prof. H. J. Emeléus, 5.45 p.m., University College of North Wales, Bangor. Joint meeting with the R.I.C.

December 5. ' Chemistry in Higher Technological Education,' by Dr. H. J. T. Ellingham, 5.30 p.m., Robert Gordon's Technical College, Aberdeen. Joint meeting with the R.I.C. and S.C.I.

The Institute of Fuel

November 12. ' Some Aspects of Feed Water Conditioning for Steam Boilers,' by C. W. Drane, 6.30 p.m., Engineers' Club, Albert Square, Manchester.

November 18. ' Flame Radiation and Furnace Design,' by G. J. Gollin, 6 p.m., James Watt Institute, Great Charles Street, Birmingham 3.

November 25. ' Experiments on the Sampling of Coal,' by E. H. M. Badger, 5.30 p.m., Institution of Mechanical Engineers, Storey's Gate, St. James Park, London, S.W.1.

November 27. ' The Work of the British Coal Utilisation Research Association,' by R. L. Brown, 6.15 p.m., Gas Showrooms, Nottingham.

December 5. 'Application of Electronics to Industrial Processes,' by J. A. Sargrove, 6 p.m., South Wales Institute of Engineers, Park Place, Cardiff.

December 5. ' Instruments and Automatic Control for Small and Medium-sized Boiler Plant,' by D. Burns, 7 p.m., Royal Technical College, Glasgow.

Institute of Petroleum

November 12. ' Sulphur Compounds in Petroleum,' by Dr. S. F. Birch, 5.30 p.m., 26 Portland Place, London, W.1.

November 18. Symposium, ' Filling, Packaging and Handling of Petroleum Products,' 6.30 p.m., Engineers' Club, Albert Square, Manchester.

Fertiliser Society

November 19. ' The Mining and Preparation of Pyrites for Acid Making,' by E. G. Lawford, 2.30 p.m., the Royal Society of Tropical Medicine and Hygiene, Manson House, 26 Portland Place, London, W.1.

Incorporated Plant Engineers

November 4. ' Chrome and Nickel Plating Processes,' 7.15 p.m., South Wales Institute of Engineers, Park Place, Cardiff.

November 6. 'Anti-corrosives,' by L. Evans, 7.30 p.m., Eastern Gas Board's Demonstration Theatre, Church Street, Peterborough.

November 12. 'An Aspect of Fuel Economy,' by H. E. Partridge, 7 p.m., Welbeck Hotel, Nottingham.

November 13. ' Gas and Oil Engines,' by A. C. Yeates, Crossley Premier Engines Ltd., 7.30 p.m., Roadway House, Oxford Street, Newcastle-on-Tyne.

November 17. ' Pneumatic Control in Industry,' by Col. R. W. W. Taylor, 7.15

p.m., Radiant House, Bold Street, Liverpool.

November 18. 'Plant Repair by Welding,' by K. K. Doherty, Lincoln Electric Co. Ltd., 7.30 p.m., Peahen Hotel, St. Albans.

November 19. 'Can Additives in Lubricating Oil help the Plant Engineer?', by A. V. Driver, 7 p.m., Bull Hotel, Rochester, Kent.

November 24. 'Conveyors as your Servants,' film by Mechanical Handling Association Ltd., 7.30 p.m., The University, Leeds.

November 27. 'Radiology and its Uses in Steelworks,' by F. Hinsley, 7.30 p.m., Grand Hotel, Sheffield.

Physical Society

November 28. 'Some Topics concerning the Production and Application of Nuclear Emulsions,' by C. Waller; and 'Paramagnetic Resonance at Low Temperatures,' by Dr. B. Bleaney; 5 p.m., 1 Lowther Gardens, Prince Consort Road, London, S.W.7.

December 4. 'Low Temperature Physics,' by Prof. F. E. Simon, 5 p.m., Science Museum, Exhibition Road, London, S.W.7.

Institution of Works Managers

November 11. 'The Organisation of the Wilton Works of Imperial Chemical Industries Ltd.,' by Dr. J. W. Armit, I.C.I. Ltd., 7.30 p.m., Vane Arms Hotel, Stockton-on-Tees.

December 2. 'Research and Management in the Chemical Industry,' by Dr. G. M. Dyson, 7 p.m., Saracen's Head, Loughborough.

Institute of Metal Finishing

November 13. 'Barrel Plating,' by B. Jones, 7.30 p.m., Engineers' Club, Albert Square, Manchester.

November 17. 'Periodic Reverse Current Plating,' by W. F. B. Baker, 6 p.m., Northampton Polytechnic, St. John Street, London, E.C.1.

December 2. 'Pumps and Filtration Equipment in Electrodeposition,' by H. Silman, 6.30 p.m., James Watt Memorial Institute, Great Charles Street, Birmingham 3.

Institution of Mechanical Engineers

November 14. 'The Mechanism of Work-hardening in Metals,' by Prof. N. F. Mott, 5.30 p.m., The Institution, Storey's Gate, St. James Park, London, S.W.1.

November 21. 'Recent Developments in the Machinability of Steel,' by K. J. B. Wolfe, 5.30 p.m., Storey's Gate.

November 28. 'The Athlone Fellowship Scheme for Training Canadian Graduates in Great Britain,' by Dr. W. Abbott, 5.30 p.m., Storey's Gate.

Institute of Metals

November 19. Symposium, 'Properties of Metallic Surfaces,' papers:

SESSION I, MORNING

(1) 'Specialised Microscopical Techniques in Metallurgy,' by Prof. S. Tolansky, London University; (2) 'Radioisotopes in the Study of Metal Surface Reactions in Solutions,' by Dr. M. T. Simnad, Carnegie Institute of Technology, U.S.A.; (3) 'Crystalline Character of Abraded Surfaces,' by Dr. P. Gay and Dr. P. B. Hirsch, Cavendish Laboratory; (4) 'Diffusion Coatings,' by D. M. Dovey, Dr. I. Jenkins and K. C. Randle, the General Electric Co. Ltd.; (5) 'Nature and Properties of the Anodic Film on Aluminium and its Alloys,' by H. W. L. Phillips, British Aluminium Co. Ltd.; (6) 'Chemical Behaviour as Influenced by Surface Condition,' by Dr. U. R. Evans, Cambridge University; (7) 'Effect of Method of Preparation on the High-Frequency Surface Resistance of Metals,' by Dr. R. G. Chambers and Dr. A. B. Pippard, Royal Society Mond Laboratory.

SESSION II, AFTERNOON

(8) 'Influence of Machining and Grinding Methods on the Mechanical and Physical Condition of Metal Surfaces,' by P. Spear, I. R. Robinson and K. J. B. Wolfe, B.S.A. Tools, Ltd.; (9) 'Effect of Lubrication and Nature of Superficial Layer after Prolonged Periods of Runnings,' by Dr. F. T. Barwell, Mechanical Engineering Research Organisation; (10) 'Effect of Surface Conditions on the Mechanical Properties of Metals, mainly Single Crystals,' by Prof. E. N. da C. Andrade, Royal Institution; (11) 'Effect of Surface Condition on the Strength of Brittle Materials,' by Prof. C. Gurney, University of Wales; (12) 'Influence of Surface Condition on the Fatigue Strength of Steel,' by R. J. Love, Motor Industry Research Association; (13) 'Influence of Surface Films on the Friction and Deformation of Surfaces,' by Drs. F. P. Bowden and D. Tabor, Cambridge University.

From 9.45 a.m. to 5 p.m., Lecture Theatre, Royal Institution, Albemarle Street, London, W.1.

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Contributions

THE EDITOR *welcomes practical articles and notes on chemical engineering and industrial chemical subjects with a view to publication. All contributions, which should be fully illustrated whenever possible, are carefully considered. A preliminary letter or synopsis is advisable. Address such material to* THE EDITOR, CHEMICAL & PROCESS ENGINEERING, Stratford House, 9 Eden Street, London, N.W.1.

Manchester Metallurgical Society

November 12. 'Refractories in the Non-Ferrous Metal Industry,' by D. B. Tait, Morgan Crucible Co. Ltd., 6.30 p.m., Engineers' Club, Albert Square, Manchester.

November 26. 'Uses of Tin in Industry,' by Dr. J. W. Cuthbertson, 6.30 p.m., Engineers' Club, Albert Square, Manchester.

Manchester Statistical Society

November 12. 'Atomic Energy,' by Prof. A. J. Brown, 5.30 p.m., Reform Club, King Street, Manchester.

Society of Instrument Technology

November 25. 'Thermal Controls for the Industrial Boiler,' by D. Burns, 7.30 p.m., College of Technology, Sackville Street, Manchester.

Manchester Association of Engineers

November 14. 'Instruments and Control Gear for Chemical Plant,' by F. C. Robinson, 6.45 p.m., Engineers' Club, Albert Square, Manchester 4.

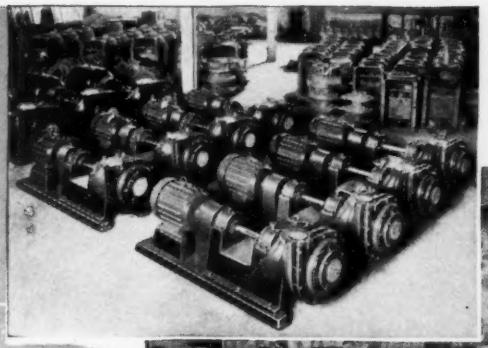
Patents

(*Concluded from page* 621)

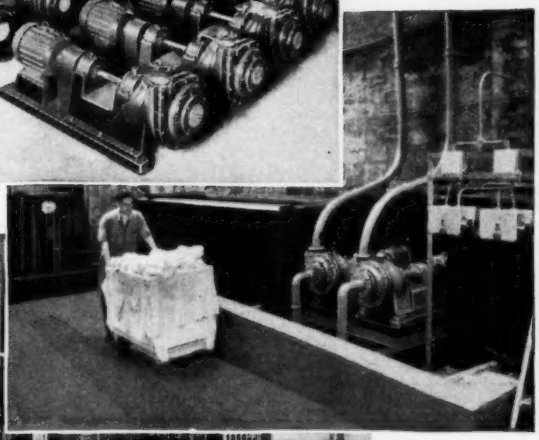
to one of the aqueous liquid, the column being preferably at 55°C.

The raffinate flows to a continuous still 15 for solvent stripping to recover regenerated scourers' liquor which may be further purified if desired. The extract solution flows to a second extraction column 21 for washing with warm water, the latter preferably containing small proportions of NaOH and an alkaline buffering agent such as trisodium phosphate. The raffinate flows to a still 27 for solvent stripping to recover the soap, etc., solution, and the remaining extract solution flows to a continuous still 31 for solvent stripping to recover the crude wool-grease. In a modification of the working of the process, the optional breaking treatment is carried out in the mixing tank 8, with or without an agglutinating reagent such as bentonite, and the clear regenerated scourers' liquor separated from the sludge and scum, which latter alone passes to the main solvent extraction stage.—617,250, *J. W. McGregor & Sons Ltd.*

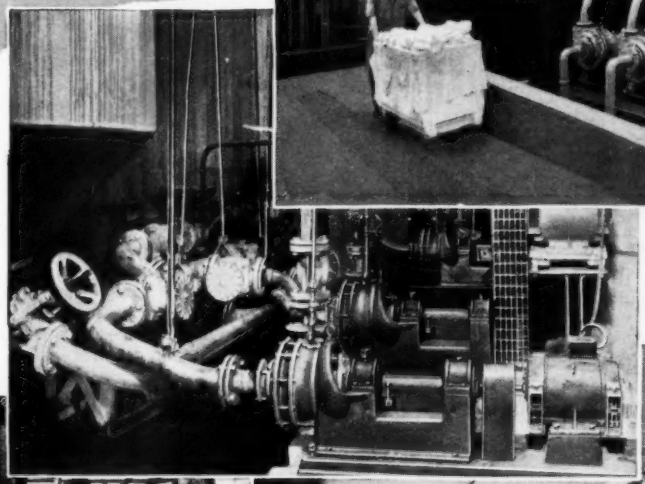
FOR PUMPING ACIDS AND CORROSIVE LIQUORS



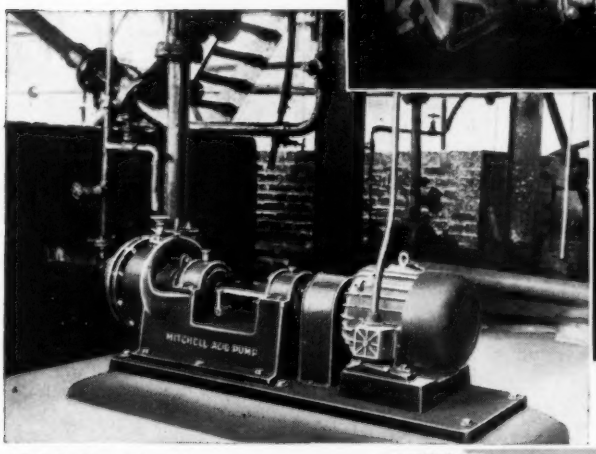
Centrifugal pumps and parts of pumps in the shops.



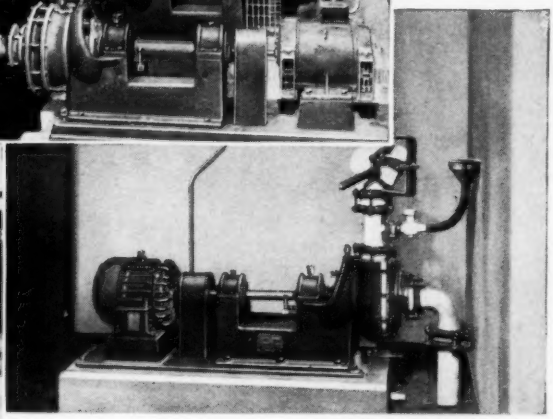
Above : Two Mitchell pumps installed at a textile factory.



An installation at a large Titanium products factory.



Mitchell acid pump installed in a chemical works.



Mitchell acid pump on duty at a large textile factory.

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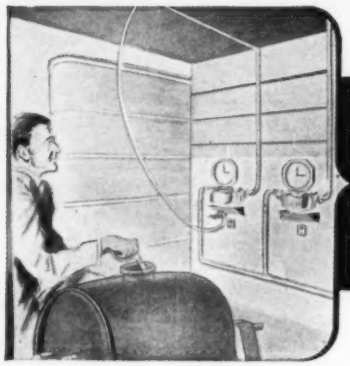

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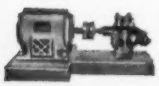

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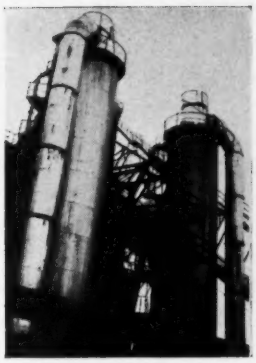

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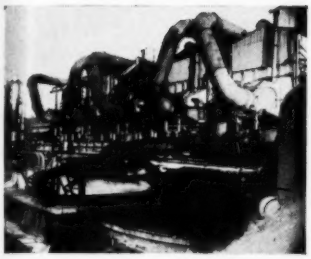

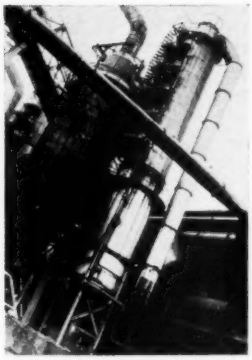

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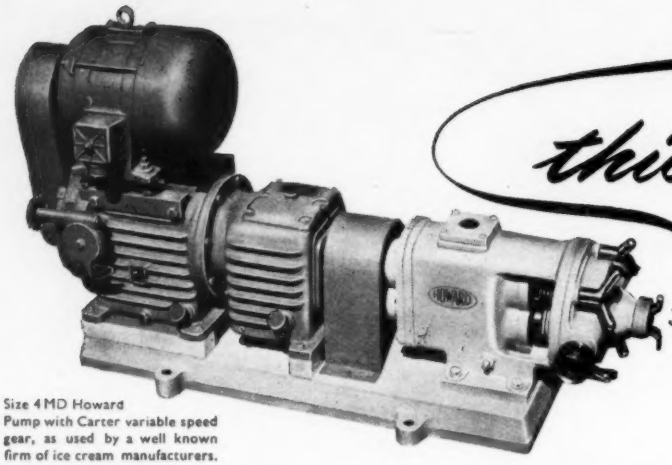

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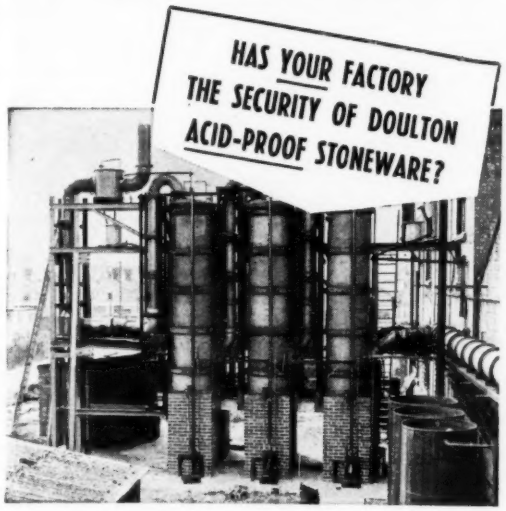

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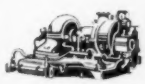

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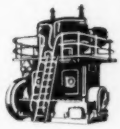

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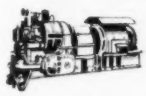

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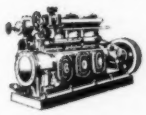

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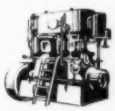

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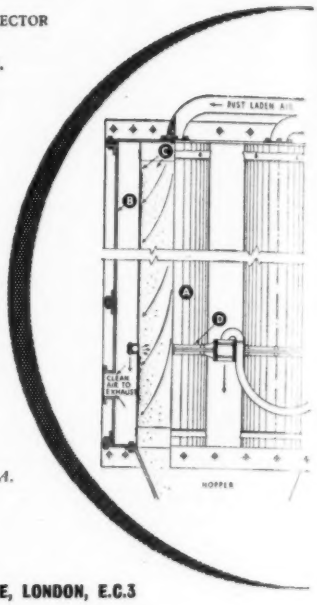

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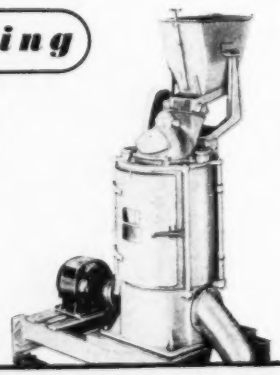

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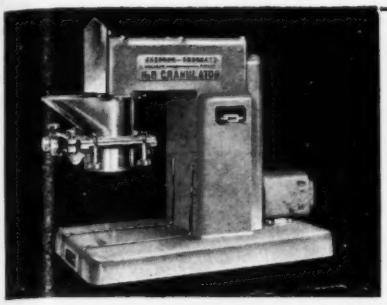

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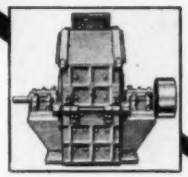

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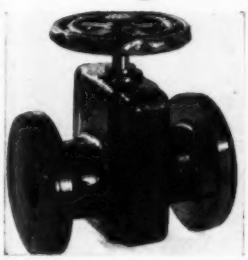

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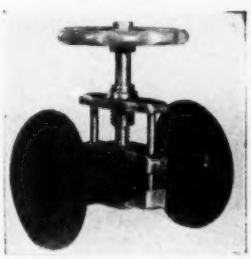

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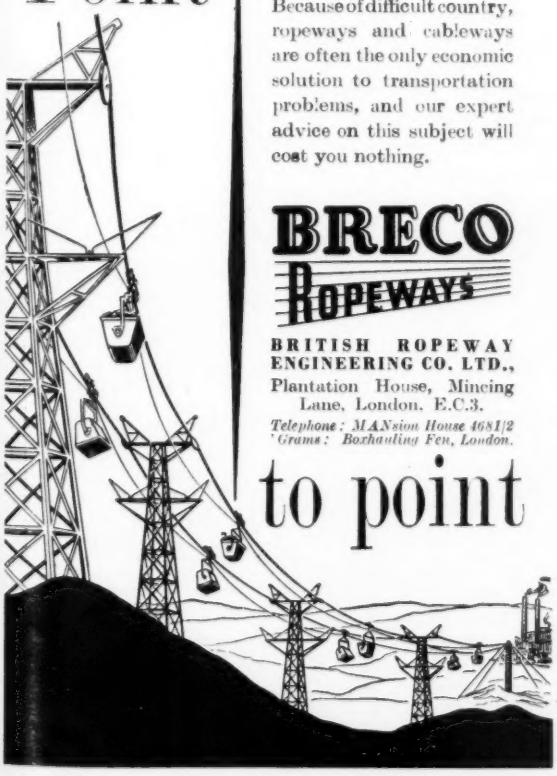

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